96/144

1981 AUTHORIZATION FOR THE OFFICE OF RESEARCH AND DEVELOPMENT, ENVIRONMENTAL PROTECTION AGENCY

HEARINGS

BEFORE THE

SUBCOMMITTEE ON
NATURAL RESOURCES AND ENVIRONMENT

OF THE

COMMITTEE ON
SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

NINETY-SIXTH CONGRESS

SECOND SESSION

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CONTENTS

WITNESSES

February 19, 1980:

Page

- U.S. Representative John N. Erlenborn, of Illinois 3
- U.S. Representative Robert McClory, of Illinois 5
- Dr. Stephen J. Gage, Assistant Administrator for Research and Development, EPA; accompanied by Dr. Vilma Hunt, Deputy Assistant Administrator for Health Research; Dr. Allan Hirsh, Deputy Assistant Administrator for Environmental Processes and Effects Research; Dr. Steven Reznek, Deputy Assistant Administrator for Environmental Engineering and Technology; and Dr. Courtney Riordan, Deputy Administrator for Monitoring and Technical Support 8

February 20, 1980:

- Dr. George R. Hendrey, Director, Land and Fresh Water Environmental Group, Brookhaven National Laboratory, Upton, N.Y. 120
- Dr. Jay Lehr, Executive Director, National Water Well Association, Worthington, Ohio 153
- Dr. Jaroslav Vostal, department head, Biomedical Science Department, General Motors Research Laboratory, Warren, Mich. 171
- Dr. Geraldine Cox, vice president and technical director, Chemical Manufacturers Association, Washington, D.C. 198

APPENDIXES

1. Background material submitted for the record by Mr. McClory, of Illinois 223
2. Questions submitted to EPA by Mr. McClory related to barium research accompanied by EPA's response 247
3. Summary of issues related to heavy-duty diesel engine emission standards 251
4. Additional questions and EPA responses for the record 257

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1981 AUTHORIZATION FOR THE OFFICE OF RESEARCH AND DEVELOPMENT, ENVIRONMENTAL PROTECTION AGENCY

TUESDAY, FEBRUARY 19, 1980

House of Representatives,
Committee on Science and Technology,
Subcommittee on Natural Resources and Environment,
Washington, D.C.

The subcommittee met, pursuant to notice, at 2:07 p.m., in room 2325, Rayburn House Office Building, Hon. Jerome A. Ambro (chairman of the subcommittee) presiding.

Chairman Ambro. I would like to begin by saying, today, is the first round in the subcommittee's formal consideration of the Environmental Protection Agency's fiscal year 1981 budget request for environmental research. Here with us to present EPA's research program is Dr. Stephen Gage, the Assistant Administrator for Research and Development.

Before we begin, I would like to say a few words about some of the issues that we will be focusing on during these hearings. The first that comes to mind affects the entire EPA research program, and that is, the quality of research.

This subcommittee and committee have been disturbed by the many criticisms of the quality of EPA's research program and results. EPA regulatory actions have great social and economic impacts. Therefore, research supporting these actions must be scientifically sound. We are going to make sure that EPA's research program moves toward these goals.

In addition to research quality, we are also concerned about EPA's responsiveness to current and emerging environmental problems. EPA has a history of reacting to problems after outside pressure forces EPA to act.

This year's budget illustrates another example of this. The hazardous waste program shows a major increase which comes after such discoveries as Love Canal. The issue here is one of posture. We feel that EPA's posture may be that of attempting to do things too far after the problem has reached critical dimensions.

We should be able to foresee what are going to be our emerging environmental problems and take steps to address them before they get worse.

I might say out of context that, so far as I can determine, the EPA has slipped its target date of January 1 for the production of an acid rain report in line with a Presidential Executive order. From what I know, with EPA acting as chairman of the task force to produce this report, the target date has passed and no report has been released. Furthermore, both in terms of the 10th Annual Report on the Council of Environmental Quality and the press release, we are regaled with the notion by CEQ that there is increased evidence of groundwater contamination because of human activity, such as the improper disposal of toxic industrial waste. Groundwater is used for drinking water by half the people in the United States, all of which this subcommittee and committee said vociferously and as strongly as we could to the EPA last year, and the year before, and the year before, and the year before, and still we have no movement in the direction of taking the kinds of steps that we feel are necessary to provide regulators with the scientific data to do a better job with respect to groundwater.

The committee is also disturbed by EPA's refusal to request funds for the Great Lakes' program and for doing less than what we asked them to do about aquatic weeds.

I must say that the EPA and this subcommittee can work in harmony if, indeed, we can arrive at a modus vivendi with respect to these problems. We will hear in a few minutes from Dr. Gage as to why these specific criticisms, in particular, and the general criticisms have not been addressed.

None of this, however, must impair our efforts to resolve our current environmental problems. What is needed is a balanced research program. We are willing to help EPA in reaching this balance by identifying problems for them. One that I feel is important, as I said, is groundwater contamination. After looking at the budget request, I can't say that EPA shares this view. Furthermore, other concerns that we have apparently are not shared by EPA. We see that some of the programs that we mandated last year are being cut this year. We will, of course, get into these as we proceed to review EPA's budget request for research.

As I say, there are many issues to consider and we will hear about them in due course.

Before hearing from Dr. Gage, I would like to call on my colleagues for whatever opening remarks they'd like to make, and then I'd like to call on a colleague in the audience who would like to make a statement.

Mr. Watkins?

Mr. WATKINS. Thank you, Mr. Chairman. I have been anxiously awaiting this particular hearing because I have been deeply disturbed because EPA's right hand and left hand, don't seem to know what they are doing, or maybe I have been told one thing and I see other things happening.

I would like to get some things on the record here today, or submitted to us for the record on the direction in which the EPA is going with their research and how they plan to get there.

It seems like appropriations have already been authorized, and there seems to be a shifting of dollars in the direction of someone who has priority down at the agency and not in the direction expressed by this subcommittee.

I will probably make a little more personal statement in a few minutes, and I will apologize in advance if I make some personal statements after awhile because I have been concerned about this.

Thank you, Mr. Chairman.

Chairman AMBRO. Thank you, Mr. Watkins.

We have a Member, not of the subcommittee, but of the full committee with us—my friend from California, Mr. Dornan. Would you like to say something?

Mr. DORNAN. No, Mr. Chairman. I just wanted to sit in for general interest.

Chairman AMBRO. Thank you.

I would like now to welcome one of our friends and colleague from Illinois, Mr. Erlenborn, who would like to address the subcommittee on a matter of special interest to him. We are happy to have you here.

STATEMENT OF CONGRESSMAN JOHN N. ERLENBORN

Mr. ERLENBORN. Thank you, Mr. Chairman, members of the subcommittee. I will only take a moment of your time. Let me say first that I appreciate the opportunity to appear before the subcommittee to call attention to the need for further scientific research on the barium and radium standards for community drinking water which has been promulgated by the EPA. I would also like to submit a more detailed statement on the same subject on behalf of my colleague from Illinois, Bob McClory, who was scheduled to testify, but is unable to be here He hopes the subcommittee will ask Dr. Gage to reply to them in writing, for the benefit of the subcommittee.

Along with that, Mr. McClory has submitted seven written questions. He hopes the subcommittee will ask Dr. Gage to reply to in writing, for the benefit of the subcommittee.

I don't pretend to possess any great degree of expertise in this matter, and I will not attempt to recount all of the studies which have raised legitimate questions about the validity of the current EPA standards. You will find that Mr. McClory's statement provides a considerable amount of documentation in this area.

Instead, I would like to address myself to what I perceive to be a simple matter of common sense. Under the present circumstances, EPA is proposing that a number of small towns and communities be required to incur a great amount of expense in treating local sources of drinking water in order to reduce the levels of barium and radium. This would all be well and good if the danger of such substances in the drinking water had been demonstrated by conclusive scientific study, and there had been convincing evidence that levels in excess of the standards were, in fact, hazardous.

Unfortunately, this does not appear to be the case. Now I certainly am not opposed to safe drinking water, and I doubt that many local officials are either, but there seems to be some justification for questioning the reasonableness of the EPA's barium and radium standards.

It is my understanding that the current barium standard for drinking water is based upon an unrelated study of barium levels in the air which was conducted at the Los Alamos Laboratory during the early 1950's and, as Mr. McClory points out, this study had nothing to do with toxicity. Admittedly, I am not a scientist, but it seems absolutely inconceivable that Federal water standards could be based upon studies of contaminates in the air.

The University of Illinois has conducted one of the few, if not the only, study of barium actually existing in drinking water. The results were inconclusive, and even the EPA which reviewed the study commented that it "did not produce a distinctive conclusion that permits us to recommend a safe standard for barium in drinking water."

It is beyond me to explain how a Federal agency can impose these costly drinking water standards on the basis of such flimsy evidence—evidence that relies upon outdated studies of the air to determine water standards and evidence that the agency itself admits is inconclusive. I certainly don't think it is prudent to require small communities with limited budgetary resources to adhere to such dubious barium standards.

I might add that there is also sufficient reason to believe that the EPA standard for radium is founded upon evidence that is just as weak as the support for the barium standard.

The immediate concern of affected local communities in my congressional district and elsewhere relates to enforcement of the January 1981 deadline for compliance with the Safe Water Drinking Act. I am aware that this subcommittee has no direct role in the enforcement of these questionable standards. The Interstate and Foreign Commerce Subcommittee on Health and the Environment considered this matter during field hearings in Chicago late last year. It has indicated that it will take up the enforcement issue again during the current session.

Your subcommittee, however, has a more basic role in resolving the current controversy. Only through additional research and study can we ultimately determine what levels of barium and radium in our drinking water are safe and acceptable. I strongly urge this subcommittee to insist upon additional study and research of barium and radium levels in community drinking water so that accurate, meaningful, and reasonable standards may eventually be established.

Thank you, Mr. Chairman.

Chairman **Ambro**. Thank you very much.

I might comment, in a colloquy on the floor late last year, I assured our friend Mr. McClory of our concern and of our dedication in terms of persuing this most serious problem.

An analogous situation developed in my district with respect to the intrusion of industrial organics in the absence of a veritable standard; and, as a result of that and other difficulties, we recognize that the gap between the promulgation of regulations and the support research is a problem of monumental concern. We try to tilt the Agency in the direction of understanding the relationships between regulations and the data that this component of that agency should develop.

So with that assurance, I thank you very much for your statement and assure you once more that we are both concerned and will pursue the matter.

Mr. **Erlenborn**. Thank you very much, Mr. Chairman.

Chairman **Ambro**. Dr. Gage? Aren't you glad you are here?

Dr. **Gage**. Of course, Mr. Chairman. It might be less troublesome later on if I have my colleagues join me at the table at this time.

Chairman **Ambro**. While you are doing that, let me say that we will include the statement of Mr. McClory in the record.

[The prepared statement of Representative Robert McClory, of Illinois, is as follows:]

STATEMENT OF HON. ROBERT McCLORY, CONGRESSMAN FROM ILLINOIS

Mr. Chairman and Members of the Subcommittee on Natural Resources and Environment, I appreciate the opportunity to testify on the urgent need for scientific research related to the current US EPA standards of 1.0 mg/1 barium and 5pCi/1 radium in community drinking water supplies.

After a careful study on my part, with the aid of highly qualified scientists, I found that the current barium standard was based on an extrapolation and adjustment of information taken from an industrial hygiene study which recorded the amount of barium present in the air at the Los Alamos Laboratory in New Mexico during the period 1950–1953. I have obtained from Mr. Edwin C. Hyatt, who conducted this study along with Dr. M. F. Milligan, a statement which I hereby submit for the record indicating that this study had nothing to do with the toxicity of barium but merely recorded the levels of barium nitrite present in the air, to which workmen were exposed.

Although this report related to barium in air, not water, and had nothing to do with toxicity, I should advise the committee that this outdated and essentially irrelevant data was used as the basis for setting the current standard of 1.0 mg/1 barium in communiy drinking water supplies. This is clearly inadequate research. For your further edification, I submit statements of Dr. Robert Larsen and Dr. Robert Rowland of Argonne National Laboratory which refer to this original Hyatt-Milligan study. These two distinguished scientists effectively reject the EPA's evidence as a scientific basis for the establishment of a barium standard in community water supplies.

The only research specifically addressing the issue of barium in drinking water was conducted by the University of Illinois under the direction of Dr. R. G. Brenniman. It was found by the authors of this research and by the US EPA Laboratory in Cincinnati that "this study did not produce a distinctive conclusion that permits us to recommend a safe standard for barium in drinking water." *

Notwithstanding this flat disclaimer, the US EPA has persisted in its determination that the current standard of 1.0 mg/1 barium should remain in effect.

Although I know that the primary responsibility of this Subcommittee relates to research and not regulation, I was particularly interested to read the Science and Technology Committee statement on page 20 of House Report 96–58 authorizing the fiscal year 1980 appropriations for EPA research and development, wherein it is stated that ". . . the Committee recommends that health effects research give proper emphasis to removing the uncertainties (such as exposure and tolerance levels) associated with substances already on the regulatory agenda. The Committee is concerned that too much past research has focused on compiling lengthy lists of potential hazards and not enough on establishing estimates of total human exposure, the relative risks of various hazards and the prediction of human health effects at typical exposure levels. The Committee intends that the Agency not neglect these latter kinds of research in its program."

This is certainly a strong statement by this Committee indicating a determination that research be conducted on substances already regulated to determine the proper exposure and tolerance levels of those substances rather than simply identifying them as potential hazards to human health. I totally agree with your Committee in this regard. That is why I feel the urgent need for further scientific studies to determine what standard should be established for barium in community water supplies. We should determine at what level barium would be toxic to human health, since I understand the lethal dose of barium, at the very high level of around 500 mg/1, is the only known toxic figure related to barium in water.

Although it is not your major responsibility, I also want to add at this time that I believe standards for drinking water should not be enforced until scientific research has indicated the need for such a standard and the proper level for setting such a standard. It can be stated without contradiction that almost any ingested substance would be harmful to human health at excessively high levels.

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*Foreword of EPA–600/1–79–003. January 1979. "Health Effects of Human Exposure to Barium in Drinking Water" by G. R. Brenniman, W. H. Kojola, P. S. Levy, et al., Department of Commerce NTIS No. PB–292 268.

However, at low or moderate levels these same substances might be quite harmless and possibly even beneficial to human health. For instance, I am submitting for the hearing record, attached hereto, a British study showing that where barium concentrations in the water of South Wales were high there were fewer neurological birth defects. This article by M. S. Morton, P. C. Elwood and M. Abernethy entitled "Trace elements in water and congenital malformations of the central nervous system in South Wales" was published in the British Journal of Preventive Social Medicine in 1976, Volume 30. Dr. Jeffrey Bland of the University of Puget Sound, Takoma, Washington, referred to the British articles in the October 1979 issue of Osteopathic Medicine, and I am also submitting his article for the hearing record. Although this British study cannot be considered conclusive, it shows a positive effect of barium in drinking water and I feel this positive effect should be considered along with any possible negative effects of barium.

My main concern is that the small communities in my 13th Congressional District of Illinois, as well as some communities nearby, should not be forced to meet a standard imposed by the federal government which has not been scientifically substantiated by the federal EPA by any responsible scientific studies—as the Congress must have intended in passage of the Safe Drinking Water Act of 1974. To many of these small communities of approximately 3,000 to 15,000 population, the cost of installation and maintenance of a treatment plant plus the ensuing sludge treatment systems which would be required would be extremely burdensome, particularly when the officials of these communities maintain that such improvements are deemed to be unnecessary and not scientifically substantiated. These community officials live in these areas and drink the water themselves. They want to know if it poses a hazard to human health. They, more than anyone else, would want to treat the water with the community's own resources or with federal assistance, if necessary. But they regard it as highly unfair for a federal government agency to put the cart before the horse (so to speak) and require compliance with a standard before providing substantial scientific evidence that the standard is justified.

One of the communities in my Congressional District, West Dundee, Illinois, participated in the epidemiological Brenniman study which, however, did not provide substantial information by reason of the failure to address several variables such as the presence of water softeners in a number of homes, which add salt to the diet, and the fact that substantial population changes reduced the study to little use.

The Village of West Dundee, indeed, would like to have its community water supply used for scientific experiments. The barium content in the West Dundee water is approximately 8.1 mg/1 and this same well has been in use in West Dundee for the past 25 years. The water in this community's water system contains barium and other elements found naturally in the water obtained from its deep well.

The testing of this water as it is actually received and used by the citizens of this community would produce more accurate results then testing distilled water to which barium has been added. For instance, elements in combination react on one another. Some scientists believe that barium reacts with sulphate and other elements as it travels through the human body to produce barium sulphate which is virtually harmless at low levels. Most of this barium sulphate is eliminated from the body within two days. To help shed some light on this I am submitting for the record two statements made by Dr. Frank Fiorese, Chief Toxicologist for both the Silver Cross Hospital in Joliet and the Arlington Heights Hospital in Arlington Heights, Illinois, who has had over 30 years of experience as a toxicologist, the first statement submitted by the City of Crystal Lake for the November 5, 1979 field hearing in Chicago of the Subcommitee on Health and the Environment of the House Committee on Interstate and Foreign Commerce,[1] and the second statement submitted after that hearing in response to a report of Dr. Andrew Reeves of Wayne State University in Detroit for the U.S. EPA.[1]

For these—and other—reasons the most important scientific studies relating to barium in community water supplies would seem to be to study the water as it occurs naturally in a community such as West Dundee. In addition, these studies could include the identification of individuals who have been drinking this water for 25 years and study what, if any, physical effects it may have had on them in contrast with the condition of the population in general.

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[1] These statements have been retained in the Committee files and are not included in this hearing transcript.

I would like to bring to your attention another interesting problem brought out by the City of Crystal Lake, Illinois. Crystal Lake has been treating their water for some time according to EPA guidelines in an attempt to reduce the barium content to 1.0mg/1. Unfortunately, they have found that they cannot consistently reduce it to less than 4.0 mg/1 barium even though they are treating it according to approved methods. I hope that the smaller villages will not be forced. at great expense, to make the same mistakes that the City of Crystal Lake has already discovered. Therefore, I am submitting for the record the statement of the City of Crystal Lake for your consideration as further studies related to the treatment of water to remove barium may be contemplated.

With regard to radium, all parties concerned realize that it is dangerous at some levels, but scientists at Argonne National Laboratory who have been studying the effects of radium on human beings for several years have concluded that the present radium standard of 5pCi/1 in drinking water is set lower than is necessary to adequately protect human health.

I wish to submit for the record a statement of Dr. Robert Rowland of Argonne National Laboratory regarding the effects of radium in drinking water and an Illinois EPA article "Radiation in Public Water Supplies" by D. L. Bennett, Supervisor, Water Quality Unit. If it is determined by scientific data that the barium and radium standards should be adjusted upwards, the communities whose water supplies contain barium and radium at relatively low levels but in excess of the present standards would not have to be treated.

Therefore, I urge that additional studies be conducted on the effects of barium and radium on human health as the barium and radium are found naturally in drinking water supplies, so that a reasonably accurate determination can be made of the actual level at which these elements might be harmful. It may be appropriate to assign a margin of error to assure complete safety. I understand that even with the addition of such a margin of error factor, the present standards could be safely raised. Again, I feel it is patently unfair to these communities to be forced to comply with standards prior to the time of establishing current scientific data which may thereafter be carefully assessed and a more accurate standard may be promulgated.

Mr. Chairman and fellow colleagues, I fervently urge you to vote to insist on scientific research to better assess the current EPA barium and radium standards. I also hope a way will be found to prevent these small communities from having to comply with standards before they are scientifically justified. Thank you for allowing me this time to share these vital concerns with you.

Attachements, (see appendix 1.)

Chairman AMBRO. As a followup to the request of Mr. Erlenborn, I would ask you to respond in writing to the seven questions that have been asked of you through this subcommittee with respect to this problem. (See appendix 2.)

Dr. GAGE. We certainly will.

I might in the beginning indicate that the Environmental Protection Agency, in particular, the Office of Research and Development did sponsor the studies with the University of Illinois which shed light on the maximum containment level at which radium might have toxicological effects.

The interim standard which Mr. Erlenborn was referring to was set by the Office of Drinking Water based on 1962 Public Health Service data. This was done because, at the time the Safe Drinking Water Act was passed, a very tight deadline was set by the Congress and there was no time to do any research. I think it is signatory to note that a study which we've done after the interim standard was set is probably going to lead to a modification in the final standard, which the Office of Drinking Water has under investigation right now.

So we will work together with our colleagues in the Office of Drinking Water and respond to Mr. Erlenborn's questions.

That's a good example of where we've had to do research after the fact, after the political statement has been made that we are going to control the contamination of drinking water, forcing us to use data which is out of date.

Chairman AMBRO. I don't want to be contentious nor do I want to interrupt, but it seems to me that we have shed light on a variety of problems and have tried to get the attention of the agencies, especially, your office for years.

I think, while we start this session off in an amiable discussion of the budget, we will zero-in on the gaps as we see them between the problems that we all have and the research that should be done to support those meaningful regulations that we all look to—the safeguards.

Why don't we shift to the statement and the review of the budget, and then we will get to the more debatable parts.

STATEMENTS OF DR. STEPHEN J. GAGE, ASSISTANT ADMINISTRATOR FOR RESEARCH AND DEVELOPMENT, EPA; ACCOMPANIED BY DR. VILMA HUNT, DEPUTY ASSISTANT ADMINISTRATOR FOR HEALTH RESEARCH; DR. ALLAN HIRSH, DEPUTY ASSISTANT ADMINISTRATOR FOR ENVIRONMENTAL PROCESSES AND EFFECTS RESEARCH; DR. STEVEN REZNEK, DEPUTY ASSISTANT ADMINISTRATOR FOR ENVIRONMENTAL ENGINEERING AND TECHNOLOGY; AND DR. COURTNEY RIORDAN, DEPUTY ADMINISTRATOR FOR MONITORING AND TECHNICAL SUPPORT

Dr. GAGE. I am pleased to be able to present our fiscal year 1981 budget request at this time. I have with me my four colleagues—the four Deputy Assistant Administrators for Research and Development. To my far right is Dr. Steven Reznek, the Deputy Assistant Administrator for Environmental Engineering and Technology. Next to Steve is Dr. Allan Hirsch, the Deputy Assistant Administrator for Environmental Processes and Effects. To my left is Dr. Vilma Hunt, the Deputy Assistant Administrator for Health Effects Research. To Vilma's left is Dr. Courtney Riordan, the Deputy Assistant Administrator for Monitoring and Technical Support. They will be giving part of this overview as well.

Before turning to the detailed presentations which they will discuss, I would like to talk a little bit about some of the improvements in EPA's research planning and management which have occurred during the past year and which will continue into fiscal year 1981, as well. [Slide 1.]

Slides – p. 13 of
transcript for 2/14/86

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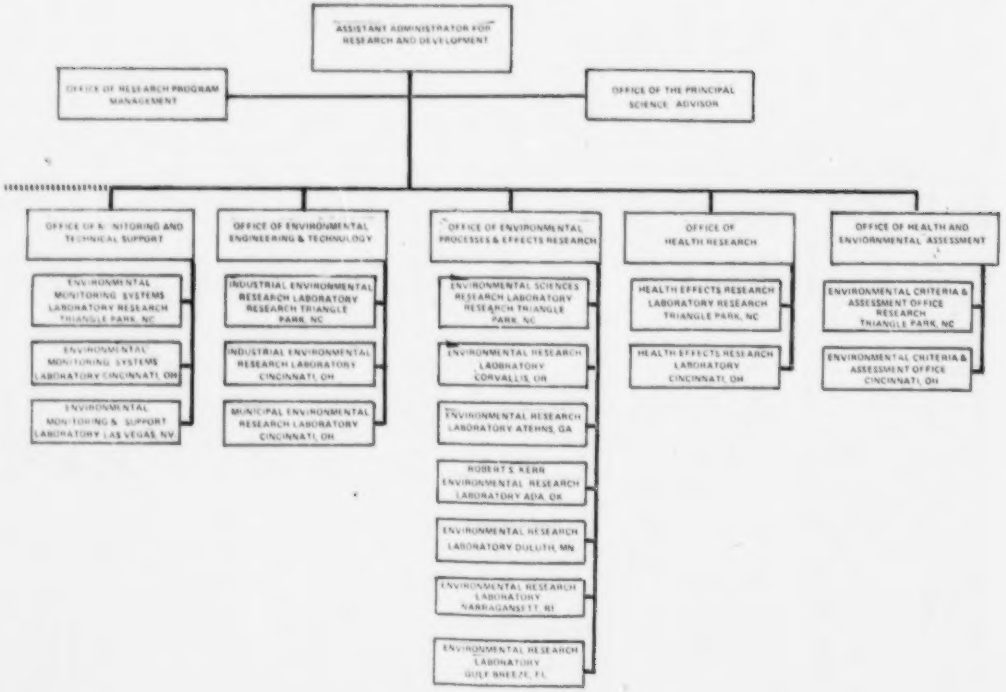

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SLIDE 1

I'd like to talk about the three areas of emphasis that we have been focusing on: First, better integrating of research and development into the mainstream of the Agency's regulatory and enforcement activities; second, enhancing our capability to provide the scientific and technical data to impact EPA's decisionmaking; and, third, improving the quality of that data which we provide. In support of all three of these objectives, we have been improving ORD management systems to make better utilization of the resources which we get from the Congress.

I would like to begin with the integration of our research and development activities into the mainstream of EPA.

In the past 2 years, we have established a system of research committees which have had a very fundamental impact on the planning of our research and development activities.

Twelve research committees were formed prior to the fiscal year 1981 and the 13th is being formed now.

Chairman **Ambro.** Steve, do we have copies of these slides?

Dr. **Gage.** All of the written material has been presented to you. That one is in the testimony.

We will be furnishing copies of all the slides, other than some of the pictures which are in color. [Slide 2.]

RESEARCH COMMITTEES AND
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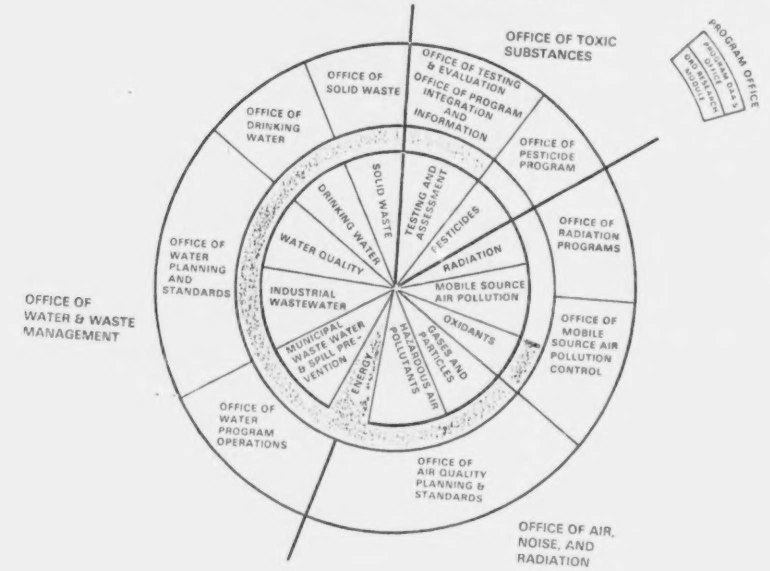
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OFFICE OF PROGRAM INTEGRATION AND INFORMATION
OFFICE OF SOLID WASTE
OFFICE OF DRINKING WATER
OFFICE OF PESTICIDE PROGRAM
OFFICE OF RADIATION PROGRAMS
OFFICE OF WATER PLANNING AND STANDARDS
OFFICE OF WATER & WASTE MANAGEMENT
OFFICE OF MOBILE SOURCE AIR POLLUTION CONTROL
OFFICE OF WATER PROGRAM OPERATIONS
OFFICE OF AIR QUALITY PLANNING & STANDARDS
OFFICE OF AIR, NOISE, AND RADIATION
SOLID WASTE
TESTING AND ASSESSMENT
DRINKING WATER
PESTICIDES
WATER QUALITY
RADIATION
INDUSTRIAL WASTEWATER
MOBILE SOURCE AIR POLLUTION
OXIDANTS
MUNICIPAL WASTE WATER & SPILL PREVENTION
ENERGY
HAZARDOUS AIR POLLUTANTS
GASES AND PARTICLES
PROGRAM OFFICE
PROGRAM OAA's OFFICE
ORD RESEARCH MODULE

Slide 2

The research committees have responsibility, not only for doing the ORD planning for the next budget year, but also for developing multiyear research strategies to guide the preparation of our research planning over several years.

I think these strategies are a very major step forward in EPA planning because, up until just 3 years ago, there were not multiyear strategies either in the regulatory part of the Agency or in the research portion of the Agency.

So in working together with our regulatory counterparts, we have launched these 3 to 5-year research strategies. These provide the intellectual underpinnings for the research committee activities.

With the inclusion of our 13th research committee this year—the Energy Research Committee—we are now planning over 90 percent of the research and development activities of the agency jointly with the regulatory programs.

A more recent improvement in this process is the establishment of a Research Council which I chair and which is composed of the Research Committee Chairmen and the Office of Research and Development's Deputy Assistant Administrators.

This Research Council really allows us to integrate the program-oriented research committees with the line management as represented by the Deputy Assistant Administrators.

In the past year, we also wanted to enhance our capability to develop the data to impact Agency decisionmaking. The laboratory realinement which was completed, I believe, this last summer really alined the laboratory reporting relationships along functional lines, so that we have an Office of Engineering and Technology Research, we have an Office of Health Research, et cetera.

These relationships are much easier to understand and much easier to administer. I think this organization is helping us.

The establishment of the Office of Health and Environmental Assessment, as shown in the lower right-hand corner of the slide, is helping a good deal to take the scientific data which our researchers and researchers outside the Agency develop and sharpen the interpretation of that data into a form which is useful for the regulatory decisionmakers. That office, for instance, is responsible for the air quality and water quality criteria documents, which are used as scientific bases by our regulatory counterparts.

We are also very busy at this time developing an ORD-wide performance management system for our Senior Executive Service employees and our merit-pay employees. The latter category includes all GS-13's through GS-15's who have supervisory responsibilities. These are two new responsibilities which we have under the Civil Service Reform Act. We are taking those very seriously and see the real opportunity here to link our program strategies together with our required accomplishments and commitments by the individual managers to deliver on those accomplishments. Of course, as is written into the Civil Service Reform Act, there are very substantial salary incentives to back up our rating of those individuals for doing a good job.

I think these actions do promise to further enhance our capability to provide data to support the near-term regulatory needs of the Agency.

We are not neglecting the long-term research either. We have moved in the past 2 years, starting with a very small program, our anticipatory program, toward a much broader and a more stable base for long-term research. At this time, we are creating a new Office of Exploratory Research which will be responsible for several functions.

These functions include the centralized competitive grant program, which I think will encourage much wider competition for some of our grant resources and provide much better peer review both of the grants before they are awarded, because we will be using the best scientists around the country to give us a relative ranking in the grant proposals and of the grant results after the projects are completed.

I would like to submit for the record a copy of the solicitation, which we have now sent to over 8,000 researchers, to invite their participation in this competitive grant program. This, by far, is the widest solicitation that ORD has ever conducted, and we are very hopeful that the increased number of good grants will improve the quality of work that we are doing, particularly in this area of longer term or anticipatory activities.

Chairman AMBRO. We will accept it as a committee document.

Dr. GAGE. Thank you, Mr. Chairman.

Chairman AMBRO. Why do you use the word "exploratory"? Is that a new word as applied to outer space?

Dr. GAGE. I think it could be quite evocative of the kind of research we are attempting to fund through this program.

We are exploring the frontiers of scientific knowledge, the frontiers of our understanding of what are the real environmental problems out there in the real world. It is the kind of a program that you spoke of in your opening remarks—trying to anticipate problems before they are on us, to get some hint that these waves are going to be crashing about our heads in a matter of a few years or, in some instances, in a few months from the time they are first discovered.

Chairman AMBRO. So you will tell us sooner or later where the exploratory funds would be located in this budget breakdown.

Dr. GAGE. Yes; I would be happy to.

The Office of Exploratory Research will also have responsibility for our environmental research center support program, as this committee is well aware. This was started in response to the fiscal year 1978 authorization bill which encouraged us to study the feasibility of using universities as a base for expanding our work in exploratory research.

We have established three centers already, and we plan to establish four more during fiscal year 1980. We are again using very wide solicitation to invite as many universities that are interested who have expertise in these areas to participate. I would like to submit our participation brochure.

Chairman AMBRO. We will accept that as a committee document, too, without objection. That does not mean we will include it in the record.

Dr. GAGE. I understand. I just wanted to call it to your committee's attention.

Also, under the Office of Exploratory Research, we have our long-range forecasting in strategic assessments. That responsibility is very important in informing our research committee chairmen in the development of 5-year strategies, so they stretch out beyond the horizon that they see immediately in front of them, which are largely driven by the short-term requirements in the regulatory offices.

That particular function has already resulted in the preparation of our draft of the environmental outlook. This has been used very substantially in the preparation of our mandated research outlook which has already been sent to the Congress.

I remember last year at this time I got some particular comments on the fact that our research outlook had been late the year before and that it had better not be last year, and it was not late last year. It was on time, as was the research outlook—our 5-year plan—this year.

I think the fact that we do have a smoothly running operation to prepare and update the long-term projections and feed those into the research committees so those chairmen can prepare the respective chapters in the research outlook gives us an onward-moving 5-year plan which, in fact, now works.

In the area of improving the quality of our research data, I would like to mention several things. First, beyond the use of peer review mechanisms for the grants that I mentioned earlier, we are also moving vigorously toward expanding peer review across the Office of Research and Development. We have established very strict peer-review policies which have been agreed to by the deputy assistant administrators and the laboratory directors.

This encourages publication in peer-review journals and is probably the best check on the quality of data because it is using the best information and best insights of scientists around the country.

We are also conducting reviews at the assistant administrator level. These are typically reviews which cut across areas common to more than one office. In many cases, there are three or four offices.

We have a review coming up in March which is going to address the procedures for analysis of toxic-materials in soils and sediments and in biological tissue. I think that is going to be very important to see how these programs relate to one another across the four offices represented here by the DAA's.

We are using much more of the Science Adviosry Board to review all of the data and all of the analysis which we compare for the regulatory programs. This again, has been encouraged by the committee, and it has been adopted quite fully and with a great deal of support within the Agency.

I think that the Science Advisory Board is doing an excellent job in bringing criticisms of the analyses to light early in the process so that the criteria documents can be changed and can be made to reflect our best understanding of what the scientists are telling us at this particular point.

Another area where we have taken on major responsibilities for improving the data within our Agency is in the area of quality assurance. The Administrator has given the Office of Research and Development the responsibility to establish and to direct this program throughout the Agency so we are now requiring all of our R. & D. laboratories and all of the extramural projects that we fund through R. & D. to have very stringent quality assurance requirements written in and observed.

We are working with our regional offices so that the analytical divisions within the regions also have high-quality assurance procedures.

The next step will be moving beyond that to the State and local laboratories which, also, carry out analysis. I think this is a very major step forward and will make better use of our environmental monitoring resources.

I would now like to give a short presentation on the several areas of major increases within our budget and then turn to my colleagues for some further presentation.

First of all, our budget is up somewhat for the fiscal year 1981. It is up approximately $27 million to roughly $369 million for fiscal year 1981.

Our manpower resources are reduced slightly. We are down 20.5 full-time equivalent positions. That is down to 1,828 full-time equivalencies.

Mr. WATKINS. There are how many?

Dr. GAGE. Down 20.5, Mr. Watkins.

Mr. WATKINS. 20.5?

Dr. GAGE. Yes.

Chairman AMBRO. What does that mean, Steve?

Dr. GAGE. That basically translates for our organization into 20.5 individuals. The accounting term "full-time equivalency" refers to a number of work hours. It is a work unit; but, since we are basically fully staffed in all of our units, that means we are going to have to somehow lay off or lose through attrition some 20 additional people during fiscal year 1981; that's assuming we do not have to carry out selective reductions in force in some parts of the organization, which is a real possibility in one or two instances.

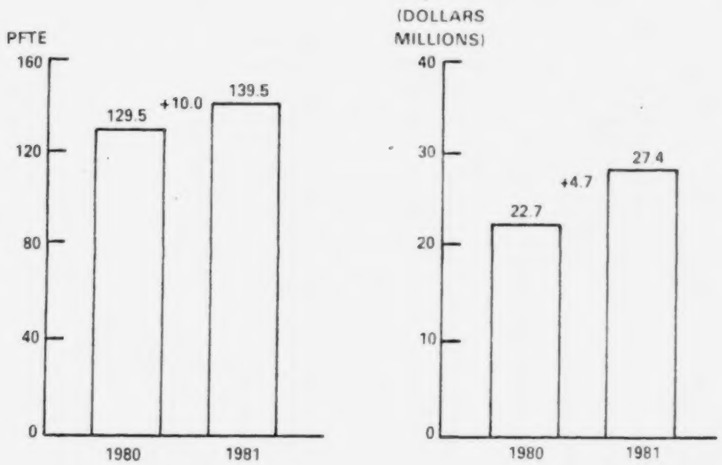
Chairman AMBRO. Is any portion of that personnel reduction made up by part-time workers?

Dr. GAGE. This covers just our full-time equivalencies. We also do have another ceiling in terms of other than full-time equivalents.

The major increases which we did receive in research and development this year all relate to the central theme of increasing our knowledge about the movement of and exposure to hazardous and toxic chemicals in the environment.

The theme affected us most significantly in the areas of solid waste, drinking water, toxic substances, and energy. I would like to begin here very quickly with the area of drinking water. [Slide 3.]

1981 R&D PRESIDENT'S BUDGET – DRINKING WATER



SLIDE 3

The major increase, as you can see here, is 10 positions as shown on the slide on the left, and $4.7 million. The major portion of this increase is devoted to the development of cost-effective technologies and multicommunity cooperative arrangements to assist localities in meeting national and State drinking water standards. This is what we have been terming as our small-systems drinking water initiative because we are focusing on the more than 80 to 90 percent of the drinking water systems throughout the country; namely, those small systems which, in more than half the instances, draw their water from groundwater sources.

What we are trying to do is work with the communities to see if there are ways in which we can transfer technology rapidly among the communities and bring the overall cost of protection of public health to contaminant drinking supplies down as quickly as possible.

Chairman AMBRO. Did you say up 10 positions?

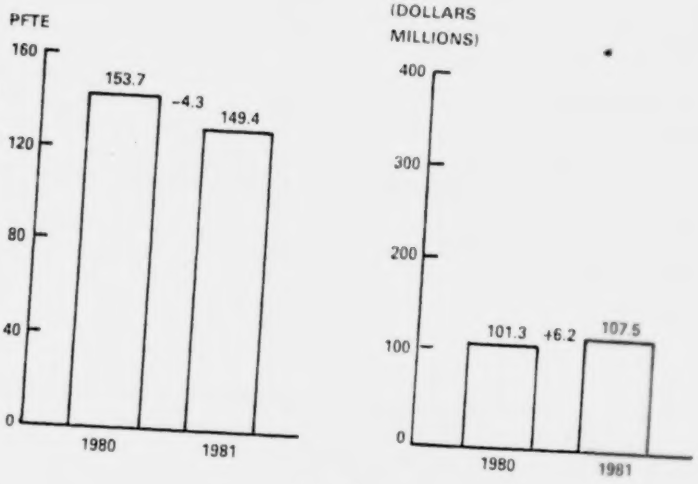
Dr. GAGE. Yes, up 10 positions.

Chairman AMBRO. Nationally?

Dr. GAGE. Yes, this is in the Office of Research and Development.

The next area is energy resources. Here we have a slight decrease in positions—four positions—for an increase of $6.2 million. [Slide 4.]

1981 R&D PRESIDENT'S BUDGET — ENERGY



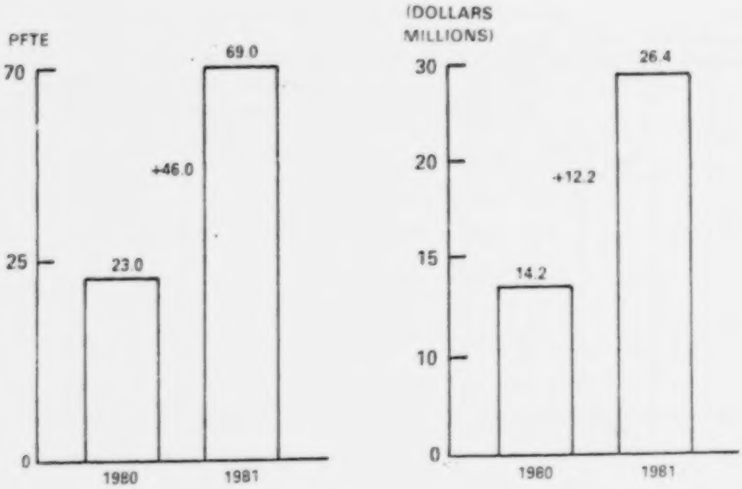
Slide 4

The bulk of this increase is to enlarge our emphasis on synthetic fuels, in particular to prepare the pollution control guidance, documents for new synthetic fuel plants, such as, liquefaction plants, gasification plants, and oil-shale facilities.

We have accepted this new increase in our energy program of building on the experience that we have had in the past 5 years because we want to make sure that the new synthetic fuel plants get off to as good a start as possible and operate in a most environmentally protective way.

The next increase I would speak to is in the area of solid waste or our hazardous waste program. [Slide 5.]

1981 R&D PRESIDENT'S BUDGET – SOLID WASTE



SLIDE 5

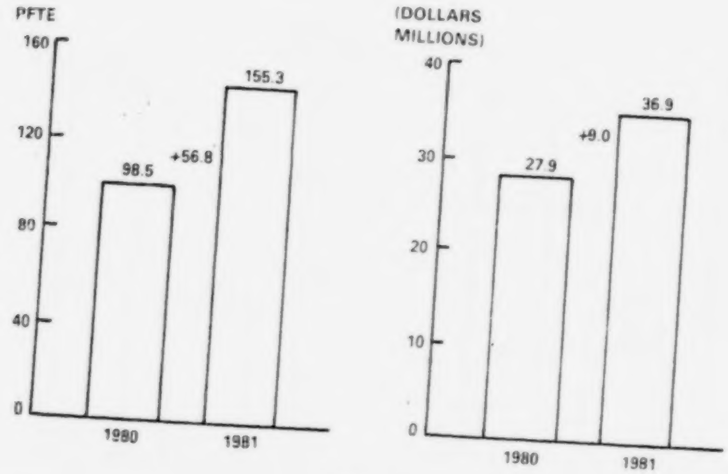
We have essentially reprogrammed over 90 percent of our resources in this program, along with the increases, to focus on our concerns with hazardous waste dumps and the handling of new hazardous wastes which are being produced daily.

There is a major increase here of 46 positions, and an increase of $12.2 million. The largest single part of the increase, $6 million, is to provide data for guidance manuals for both hazardous waste incineration and hazardous waste disposal. This is going to be a very important part of the implementation of the Resource Conservation Recovery Act. We are working hand-in-glove with our regulatory counterparts in the Office of Solid Waste.

The next largest increase is in the development of monitoring measurements methods development in quality assurance because we are frankly finding that there are just no measurement techniques available for determining what chemicals are included in the gunk that we typically find in a 55-gallon drum in back of an industry or disposed of in many of the landfills or lagoons. So we are literally having to go back and, in most cases, adapt to earlier measurement techniques to deal with this witch's brew of chemicals that we are finding throughout the environment.

The last area is the area of toxic substances and the major increase is associated with a significant reprogramming of positions from other media; namely, 56.8 positions, and an increase of $9 million. [Slide 6.]

1981 R &D PRESIDENT'S BUDGET — TOXIC SUBSTANCES



Slide 6

I should say at the outset that we have reprogramed from several media, and a substantial portion of the reduction of positions in the pesticides health area have been reprogrammed to the toxic substances area. This is to give us a better balance in the collection of people whom we have working under the many authorities, under which we are attempting to meet the research obligations. So there are 21 additional positions for health, 18 positions for ecological effects, and 14 positions for monitoring and technical support included among the 57 which I've indicated here.

This concludes the very short presentations I wanted to make in highlighting the four areas of major increases.

I should also indicate that one of the areas which is being reduced in the water quality media is the renewable resource program, which is going to be cut 14 positions and $2.5 million. This reduction will basically discontinue our extramural program in that area.

I would like to say as the last word before turning the presentation over to my colleagues that the scientists and engineers who work for each of these four deputies have been very busy and very productive during the past year.

In addition to the many planned activities which they have been involved in, they've also had to take a good bit of time to respond to a variety of major events over which none of us had any control. We've spent a number of man-years' efforts in helping to respond to the Three Mile Island accident in Pennsylvania. We've also spent a good many man-years of effort in responding to Love Canal hazardous waste problems and a number of other hazardous waste problems around the country.

We have had an instrumental role in helping prepare the case against the Hooker Chemical Co. in the Love Canal situation.

I hope we've all been able to speak to you through our Research Highlights publication which we have prepared and sent to you all. We have been very busy in dealing with the emergencies that do come up and which are not planned, but we've also made a considerable amount of progress in most of the other research areas.

With that, I would like to turn to my colleague, Steve Reznek, to begin a presentation on the activities of the Office of Environmental Engineering and Technology.

[The prepared statement of Dr. Gage follows:]

STATEMENT OF
STEPHEN J. GAGE
ASSISTANT ADMINISTRATOR
FOR RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
BEFORE THE
SUBCOMMITTEE ON NATURAL RESOURCES AND ENVIRONMENT
COMMITTEE ON SCIENCE AND TECHNOLOGY
HOUSE OF REPRESENTATIVES
FEBRUARY 19, 1980

Good morning, Mr. Chairman and members of the Subcommittee. I am happy to meet with you to present the fiscal year 1981 research and development program of the Environmental Protection Agency (EPA). Accompanying me are Dr. Vilma Hunt, Deputy Assistant Administrator for Health Research; Dr. Allan Hirsch, Deputy Assistant Administrator for Environmental Processes and Effects Research; Dr. Steven R. Reznek, Deputy Assistant Administrator for Environmental Engineering and Technology; and Dr. Courtney Riordan, Deputy Assistant Administrator for Monitoring and Technical Support.

In describing our fiscal 1981 research activities, I will discuss our major programs in turn—health effects, ecological effects, transport and fate, monitoring, control technology, and anticipatory research. For each program, I will highlight changes in funding and program emphases.

Management Initiatives

First, however, I would like to discuss the progress we've made in improving EPA's research planning and management since last year's budget hearings. Specifically, our improvements have focused on the achievement of three objectives: 1) the continued integration of research and development planning into the mainstream of the Agency's regulatory and enforcement activities; 2) the enhancement of our capability to provide the scientific and technical data EPA will need in future decision making; and 3) the improvement of the quality of these data. To support these objectives, we are also continuing to improve ORD management systems as a necessary factor in better utilization of available resources.

With respect to the first major objective, I am pleased to report that ninety percent of ORD's base program will be jointly planned for fiscal 1982 with the regulatory programs through thirteen Research Committees, twelve of which were established prior to the fiscal 81 zero-base-budgeting (ZBB) cycle. Three to five year research strategies for these twelve committees will be available in time to provide valuable guidance to the writers of ORD's decision units (DU) which will be examined in the Agency's fiscal 82 ZBB process. These strategies represent a major step forward in EPA's research planning.

Additionally, we are pursuing ways to further improve the research committee system. Three activities are particularly worthy of note here. First, a Research Council chaired by myself and composed of Research Committee co-chairmen and ORD Deputy Assistant Administrators has been established. The council enables us to approach research planning from a broad perspective and is extremely useful in addressing issues cutting across agency regulatory program lines. It also provides an effective mechanism for integrating the viewpoints of ORD's discipline oriented line management structure with those of our program oriented research committees. Second, the energy research program is being linked to the research committee process by creating a research committee to enable joint planning of the bulk of this critical program.

We have also made significant progress in improving ORD's capability to deliver scientific and technical data for future Agency decision-making. In FY 79, ORD realigned the laboratory reporting relationships to consolidate functional or discipline groupings. This realignment established an office to manage health effects research, an office to integrate environmental transport, fate and effects research, and an office to integrate control technology and hazardous waste research. ORD also created an Office of Health and Environmental Assessment to coordinate the evaluation of information on the health and environmental effects resulting from exposure to pollutants; these activities play a key role in the Agency's development of regulations. ORD is also continuing to judiciously use matrix management approaches, primarily to improve the coordination of high visibility, short-term research activities.

In parallel with these activities, we are taking steps to assure that the Agency is addressing the most important future problems and attracting the best scientific talent to work on them. Since research grants are the primary mechanism available for supporting innovative ideas, we have initiated a process to make the scientific community more widely aware of research grants, encouraging much greater competition for them and acting to insure that grants are awarded primarily on the basis of scientific merit through enhanced peer review. In FY 79, ORD undertook a rigorous review of the existing grants procedures and identified a number of measures to improve them. We are now in the process of creating an Office of Exploratory Research which will provide the organizational capability to anticipate emerging environmental problems and provide responsive research funding to solve them. In addition, we will consolidate scientific peer review and administration of research grants, including an expanded research proposal solicitation system in this new office.

Finally, we are emphasizing enhanced accountability in the conduct of our research activities. In FY 79, ORD revised its internal reporting systems to reduce paperwork and to emphasize research outputs. We are developing an automated system to reliably track critical research milestones and outputs. The milestones and outputs of key importance to the research committees will then be incorporated into this system. We are also working to develop an ORD-wide performance management system for Senior Executive Service and merit pay system employees which links together program strategies, required accomplishments, commitments by individual managers, and salary incentives to attain or surpass those commitments.

Our third objective in improving EPA's research program recognizes that the credibility and integrity of the scientific and technical data used in decision-making are crucial to the promulgation and enforcement of responsible environmental regulations. With respect to this objective ORD is moving aggressively in a number of areas. First, we are building into all of ORD's data development efforts improved review mechanisms. At the project level we are emphasizing that, whenever feasible, research results will undergo rigorous scrutiny by external experts through publication in refereed journals. We are reorienting our technical information program to encourage such journal publication. We also are moving to assure that our research findings are reaching appropriate audiences.

In addition to the peer review of individual research efforts, we are systematically reviewing entire research programs. To supplement reviews at the laboratory level, we initiated a series of cross-cutting Assistant Administrator-level program reviews in FY 79. At these quarterly meetings, we assemble the best technical people from outside EPA to critically review major research programs and outputs. We now have plans to increasingly direct our programmatic reviews along the lines of the research committees as well as high priority areas such as the FY 80 Public Health Initiative.

Finally, we are significantly expanding our efforts to improve the quality of all EPA data. Administrator Costle has given ORD the lead responsibility in implementing EPA's mandatory quality assurance program.

In direct response to this charge we are creating a quality assurance management staff in ORD Headquarters to serve as the focal point for the establishment, direction, and coordination of this program. We are also making sure our own house is in order by requiring adequate quality assurance practices for all environmental quality monitoring, sampling, and analytical activities conducted in the ORD laboratories or under contract, cooperative agreement, or grant. We are requiring similar quality assurance practices for all of the Agency's laboratories, contractors, and grantees. Lastly, we are working closely with the EPA's Regional Offices to bring quality assurance practices into uniform use in all of the State and local laboratories which provide the bulk of the environmental quality data available to the Agency.

Budget Summary

Turning now to our budget proposals, I will briefly survey the program across the several budget "media" categories and then discuss in detail the major research program categories.

Our research and development budget proposal for FY 1981 is $368.7 million and 1,828.2 permanent workyears. This is a net increase of $27.0 million and a decrease of 20.5 permanent workyears.

Figure 1 represents the FY 1981 budget by media. Within the air medium, we have an increase of $3.3 million and a decrease of 23.3 permanent workyears primarily in the air health effects research program. These permanent workyears were transferred from our health and ecological effects program and from our monitoring and technical support program to other agency priority areas. The dollar increase will support work on assessing actual human exposure by continuing to focus on epidemiologic studies, developing rapid screening techniques and developing personal monitors such as dose-response monitors for individuals.

We have decreased Water Quality by $5.1 million largely as a result of the termination of the extramural portion of the renewable resources program, leaving an in-house technical assistance effort of $319,300 and 10.0 permanent work years for this activity. Also, we will not carry forward the 1980 Congressional increase for Great Lakes research. This program will continue to stress studies on transport, fate, and effects of toxics. In addition, 43.5 permanent workyears were transferred from the water quality medium into other Agency priority areas.

The Drinking Water program has been increased by $4.7 million and 10.0 permanent workyears. These resources will be used to initiate development of cost-effective processes for small drinking water systems.

For the solid waste program we are asking for an increase of $12.2 million and 46.0 permanent workyears for a major hazardous waste research initiative. This initiative specifically calls for the development of techniques for on-site containment and treatment of hazardous wastes and for the establishment of a quality assurance and monitoring program. Some control technology efforts for municipal solid wastes are being phased out.

The FY 1981 budget reflects decreases of $3.5 million and 36.5 permanent workyears for Pesticides research. The decrease reflects several actions: a desire to shift resources to the toxic substances health research program where common needs exist for such things as analytical testing methodologies, equipment and toxicological testing methodologies, and some reduction to augment other agency priority needs.

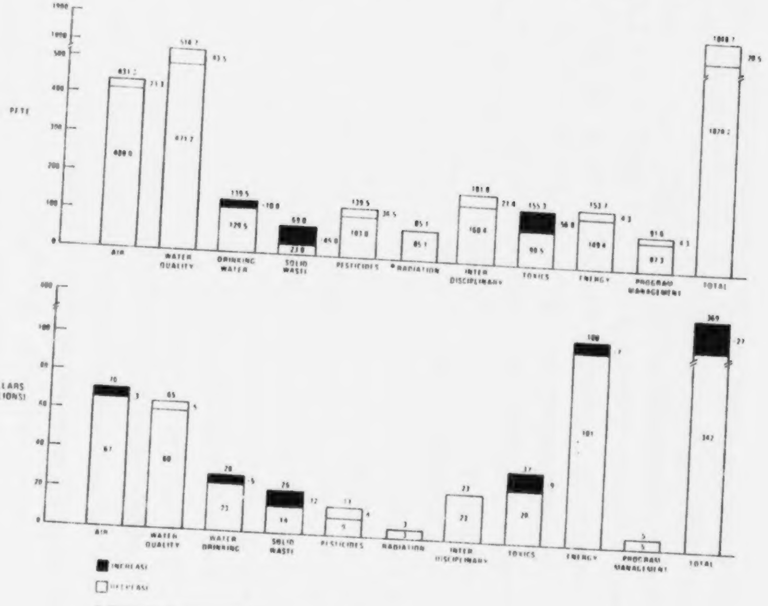
Interdisciplinary will increase by $131,300 while decreasing by 21.4 permanent workyears. The transfer of these workyears from the Anticipatory activity to other agency programs will result in some research activities being conducted on an extramural basis, rather than in-house.

The budget provides an increase of $8.9 million and 56.8 permanent workyears for the Toxic Substances research program. The permanent workyear and dollar increase will provide for the development of improved, rapid, reliable and cost-effective techniques to be used for predicting transport, transformation, exposure concentration and adverse deleterious effects on human health and the environment due to exposure to toxic substances.

Finally, for Energy research the budget includes an increase of $6.2 million. This includes additional support to evaluate control technology for the national synthetic fuels program. The increase also provides for increasing research on SO_2 control systems and on exposure monitoring.

We will now turn to a detailed discussion of our research programs. The 1981 budget by these program categories is displayed in Figure 2.

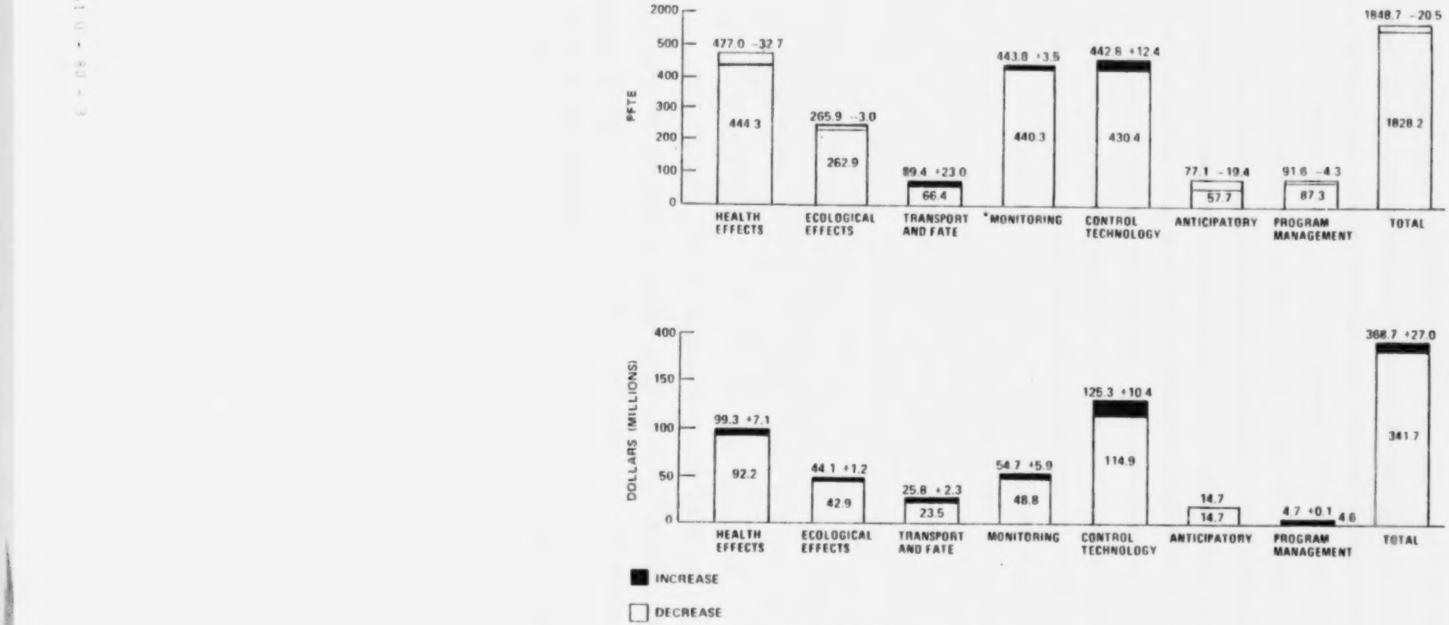
1981 R&D PRESIDENT'S BUDGET—BY MEDIA



* INCLUDES 52 PERMANENT WORKYEARS FOR OFFSITE MONITORING

FIGURE 1

1981 R & D PRESIDENT'S BUDGET BY PROGRAM CATEGORY



* INCLUDES 52 PERMANENT WORKYEARS FOR OFFSITE MONITORING

FIGURE 2

HEALTH

Within the functional area of health, EPA's research program is responsible for identifying pollutants which may pose a risk to health and for quantifying the relationship between exposure to those pollutants and their effects on health. The results of this research form the essential scientific foundation for action required to improve the environment and thereby protect the public health. Within this framework, the program provides the data base for other agency components to use in the development of criteria for setting of pollutant standards, contributes to the data base for anticipated future problems, develops the methodologies and techniques required to perform the health research and maintains a body of expertise for providing technical support.

The principal research approaches include toxicology, epidemiology, clinical studies and screening studies. These approaches address the potential adverse health effects arising from pollutants in the air; from pollutants discharged into water which affect water quality in general and drinking water in particular; from the use of pesticides and other toxic substances; from exposure to nonionizing electromagnetic radiation; from energy-related operations; and from emerging interdisciplinary problems.

The public health initiative, begun in FY-1980, is now an integral part of our health research program. It is enabling us to develop and apply a systematic approach which integrates the several pathways through which humans are exposed to pollutants. The ultimate objective of this effort is to develop strategies which prevent, interdict or reduce the adverse effects.

The FY 81 budget request is $99.3 million and 444.3 permanent work years for the health research program. This represents an increase of $7.1 million and a decrease of 32.7 permanent work years. Major changes include the following:

Air

The air health effects research program is divided into three program components addressing transportation sources, criteria pollutants, and non-criteria pollutants. The program uses epidemiological studies of specific populations, controlled human exposure (clinical) studies, and animal toxicological studies, focusing on those air pollutants which adversely affect public health or which are suspected of so doing. Investigations include (1) studies of effects from exposure to mobile source fuels and exhaust products in order to determine if these agents pose a potential threat to public health; (2) studies of effects from short-term and long-term exposures to combinations of criteria pollutants (in order to better define the health data base for these pollutants, and, therefore, to better determine the adequacy of existing pollutant standards); and (3) studies of effects from exposures to sulfates, nitrates, metal oxides, and other inhalable particulate pollutants. The information developed provides the scientific basis upon which air quality standards are established, maintained or revised as required by the Clean Air Act Amendments of 1977.

The total FY 81 request for air-health research is $29.8 million and 182 permanent workyears, providing an increase of $2.7 million and a decrease of 17 permanent workyears.

This request reflects a net increase of $265,000 and a decrease of 5 workyears for the transportation sources program, providing a total of $6.6 million and 39 permanent work years. The increase will be used to develop rapid assessment of changes in biological systems brought about by exhaust components. An increase of $1.2 million (for a total '81 budget of $6.9 million) will be used to strengthen the extramural program for clinical studies on effects from exposure to oxidants in support of the 1983 (projected) criteria document for ozone and other photochemical oxidants; and an increase of $1.3 million (for a total 81 budget of $16.4 million) in the non-criteria pollutant program will permit expansion of the extramural program to include development of animal models for pulmonary deposition and clearance of particulate pollutants, new techniques to assess impairment of host defense systems, and animal models to assess carcinogenicity of air pollutants. The remaining 12 work year decrease (for a total of 115 permanent workyears) reflects a decision not to fund in-house epidemiological studies on effects from indoor air pollution or exposure to rural fugitive dusts.

Water Quality

The health effects research program in water quality supports Agency efforts to ensure the safe treatment, disposal, and potential reuse of wastewater and sludge. This involves assessing the health impact of various technologies and developing health data bases on individual compounds for which water quality and/or effluent guidelines are to be prepared.

Requested resources for water quality health effects research in FY 1981 are $7.2 million and 32 permanent work years, essentially at the same level as 1980.

The two major thrusts of the FY 81 health research program are (1) studies related to the land application of wastewater and sludge and (2) studies which address critical data gaps on toxic wastewater pollutants. In addition, research on the safety of the potential reuse of wastewater in industry, aquaculture, and potable water supplies will continue, and the determination of freshwater recreational water quality criteria will be completed.

The program will continue to seek improved toxicological methods for predicting the impact of waterborne contaminants on human health. Comparative toxicology research will be used and, if successful, will decrease the cost of developing a health data base on particular pollutants. Blood tests which monitor dose response will reduce the uncertainties in extrapolation from laboratory animals to man and help reduce the need for high safety margins sometimes used in developing criteria or standards because of uncertainties in these extrapolations.

Drinking Water

In the health portion of our drinking water program, we investigate the relationship between hazardous effects and the presence of contaminants in water supplies. Primarily through epidemiological and toxicological studies, we help the Agency determine whether there is a need to regulate given contaminants and to what degree. The results of our studies thus contribute to EPA's efforts to insure that drinking water supplies are as safe as possible. The 1981 budget request for this program is $12.4 million and 52 permanent work years, an increase of $336,800.

The major health research activities are to investigate health effects resulting from organic and inorganic contamination of drinking water, and to evaluate alternative disinfectants to determine whether they are as effective as chlorine and whether they cause adverse health effects. The additional funding in this program of $336,800 will enable EPA to conduct research on health effects of contaminants in drinking water as they relate to human reproduction and early development.

The relationship of sodium and water hardness to cardiovascular disease will be further explored to identify individual risk factors. Epidemiological studies will be continued to establish the relationship of specific types of cardiovascular disease, especially hypertension, to sodium and/or barium levels in drinking water and heart attack rates to magnesium levels in drinking water. Toxicological studies will be conducted to determine the impact of various combinations (synergism) of calcium, magnesium, lead, cadmium, sodium and other chemical substances in water on the development of cardiovascular disease. These are long-term studies that will be conducted over the next 3 to 5 years to provide supportable data for verifying the preliminary observations.

Epidemiological studies will be completed to determine whether asbestos occurring in drinking water from natural erosion, mining operations, and asbestos-cement pipe is a contributing factor in increased cancer rates. The outcome of this research will provide the necessary data base for a treatment technique to reduce leaching of asbestos fibers.

We have already expanded our research on the reuse of wastewater for potable purposes and will continue to determine the feasibility of establishing criteria for safe reuse. Inorganic and organic constituents of advanced wastewater treatment plant effluents will be identified and additional toxicity studies performed on those substances for which little health information is available. Criteria for emergency reuse will be developed by 1985.

Health effects research on microbiological contaminants in drinking water will continue to be concerned with examining waterborne outbreaks of infectious diseases to determine the causative agent. We will continue collaboration with the Center for Disease Control to provide technical assistance and investigate ongoing waterborne disease outbreaks.

Solid Waste

Agency emphasis in the solid waste medium is now on hazardous waste identification (through development of improved analytical methods, monitoring techniques, and protocols); hazardous waste destruction (principally through incineration); and land disposal. We recognize that it is also important to have the capability to assess the health risk associated with exposures in the vicinity of hazardous waste sites. Therefore, we are requesting 2 permanent work years and $3.0 million to begin to establish a health assessment capability.

Pesticides

In FY 81, the pesticide health effects program will emphasize research on "new generation" pesticides such as viruses, fungi and bacteria. This research will include developing methods that can be recommended for certification of commercial agents, and will involve studying the effects of those agents on human populations. For data to be useful for regulatory purposes, methods for extrapolation from animal effects to human effects are necessary, requiring research on the fundamental biological activity of both chemical and biological pesticides. This knowledge will aid not only the development of creditable safety assessments but will augment the development of indirect methods of human exposure estimation. From the results of this research, standards for human exposure limitations during routine use of pesticides will evolve. The program will also support the development of new generic standards by the Office of Pesticide Programs while phasing down support for the Rebuttable Presumption Against Registration (RPAR) programs.

Since the equipment and expertise needed to assess the toxicological effects of pesticides are similar to those required for other toxic substances, much of this type of activity, which includes metabolic studies and modeling, has been transferred to the toxic substances health research program. This allows better utilization of resources and talents which will support the toxic substances program and still benefit the Agency's pesticide regulatory needs.

The total request for this program is $2.8 million and 31 permanent work years, a decrease of $3.1 million and 40 permanent work years, resulting from the above shifts.

Radiation

The radiation research program focuses on the biological consequences of human exposure to non-ionizing radiation. Of primary concern is effects of chronic exposure to low levels of non-ionizing radiation. The objectives are to ascertain the functional relationships between dose (exposure) and various biological responses. Critical biological responses to be evaluated include behavioral, immunologic, hematologic, physiologic, reproductive, teratologic and genetic factors.

In order to develop more suitable quantitative estimates of the relationship between exposure and response, we are also studying the mechanisms of interaction, damage, recovery and repair processes in several animal species.

Improvements in exposure techniques and conditions and dosimetry continue to provide the basic support necessary for health effects research.

Our epidemiological study of World War II era radar researchers will continue. Increased emphasis will be placed on refining population exposure estimates through the development and improvement of methods to account for multiple confounding variables.

The total funding requested for this program in 1981 is $3.0 million and 28 permanent work years, essentially the same as last year.

Interdisciplinary - Scientific Assessment

The scientific assessment activity is a relatively new program which incorporates both existing health and environmental assessment functions and several new initiatives begun in 1979 and 1980.

The program provides EPA's regulatory offices with a centralized capability for evaluating information on health and ecological effects from exposure to specific pollutants. Additionally, the program estimates the potential health impact and in some cases the level of risk involved from such exposures. The program reviews known information about pollutant effects, interprets this information, and produces scientific data summaries to support subsequent risk assessment or other regulatory decision making. The risk assessment portion of the program is responsible for maintaining consistency and quality among the assessments prepared throughout the Agency. To insure this, the program establishes Agency-wide guidelines and reviews completed assessments. In certain areas, the program itself conducts risk assessments and prepares criteria or other health assessment documents. Typical outputs from the scientific assessment program include reviews, guidelines (including procedures and methodologies for carcinogen and mutagenic risk analysis and exposure analysis) aquatic effects criteria documents, health assessments, reports on special health/exposure situations and both preliminary and full risk assessments dealing with, for example, carcinogenic risk.

The Agency requests a total of $5.2 million and 66 permanent work years, essentially unchanged from 1980.

Toxic Substances

The toxic substances health effects research program focuses on developing chemical screening tests to support the requirements of the Toxic Substances Control Act (TSCA). Specifically, the program is oriented toward ensuring that adequate methodologies and data are available to implement the regulatory and testing requirements of the Act.

The 1981 request in this area is $16.1 million and 46 permanent work years. This budget provides a net increase of $3.6 million and 22 permanent workyears. These expanded resources will permit greater emphasis on development of priority chemical testing protocols where techniques needed to screen effects on biological systems are currently nonexistent or are too lengthy and expensive. The principal emphasis will be on methods to screen for adverse effects on behavior, the functions of the nervous system, and the reproductive system and for causes of birth defects. The increase also reflects a redirection within the Agency of certain activities, formerly carried in the pesticide research account, relating to development of broadened testing methodologies which may apply to pesticides but also apply to a greater number of other toxic substances.

Efforts will also be directed toward development and validation of absorbed-dose determination methods for human exposure to hazardous substances, risk assessment methods, and a method for extrapolating effects observed in animals which may be expected to occur in humans.

Energy

The energy-related health effects research program identifies the long-term adverse impacts that can ensue from increased domestic energy development and use. Of major concern are those health effects that may occur as a consequence of long-term, low-level exposures and that manifest themselves only after long periods of time--cancer, birth defects, and cardiopulmonary system disorders. The necessary data are obtained through a coordinated program of clinical, epidemiological, and toxicological studies undertaken by EPA, the Department of Energy, the National Institute for Environmental Health Sciences, and the National Institute for Occupational Safety and Health, through their participation in EPA's Interagency Energy/Environment Program.

The Agency requests a total of $18.4 million and 2 permanent work years for this program in 1981, unchanged from last year's.

ECOLOGICAL EFFECTS

EPA is responsible for conducting research not only on the human health effects of pollutants, but their ecological effects as well. The ecological effects program complements the health program in that ecological effects research is concerned with the extent to which environmental pollution damages the structure, function and dynamics of freshwater, marine and terrestrial ecosystems (including stratospheric modifications); the degree to which these ecosystems can recover from pollutant stress; and the effects on human health or economic welfare resulting from the altered or damaged ecosystems.

Within the ecological effects program, we are also supporting the ecological component of the public health initiative begun last year; our efforts are designed to advance the state-of-the-art in defining and predicting the effects upon humans from exposures to toxic chemicals which are released or escape into the environment.

Outputs from this program are used in developing water quality standards, effluent guidelines for toxic and hazardous materials, ocean discharge criteria, secondary air quality standards, and dose response relationships for pesticides and other toxicants.

The 1981 budget request for the ecological effects program is $44.1 million and 262.9 permanent work years, an increase of $1.2 million and a decrease of 3.0 permanent work years.

Air

The major goal of the air ecological effects research program is to develop data to help protect terrestrial ecosystems. Consequently, this program focuses on the effects of air pollutants on the structure and functions of plant, animal and soil components of ecosystems, particularly on economically significant agricultural and forest plants. It provides the scientific basis upon which to establish and continually evaluate secondary ambient air quality standards. The FY 81 request for this program is $2.3 million and 11 permanent work years. This reflects a decrease of $93,800.

The fiscal 1981 budget continues our emphasis on the study of sulfur dioxide, ozone and nitrogen oxides, their longer-term effects at low levels and in various combinations. The National Crop Assessment Network Project will be continued. This project will provide significant information relevant to determining the economic impacts of air pollution on crops. The data provided through this project will be useful in developing and strengthening air quality control strategies. Other laboratory and field studies will evaluate the impact of air pollutants on productivity, ecosystem processes, quality alteration and genetic problems associated with crop and forest species. Research results will be used in the development of models for the forecasting of future pollutant effects.

Research will also include the identification of natural emissions of hydrocarbons and nitrogen oxides from various species of plants and the determination of the contribution of these gases to ambient concentrations of photochemical oxidants. The development of biogenic emission factors for various climatic regions will be an important output of this research. In a cooperative effort with the air chemistry and physics program at EPA's Environmental Sciences Research Laboratory in North Carolina, air dispersion and transformation models will be used to relate biogenic emissions to air pollution concentrations.

A critical part of the air ecological effects research program is to relate these effects to the important pathways, such as food-chains, leading to man.

Water Quality

The water quality ecological effects program is designed to determine the effects of pollutants in freshwater and marine ecosystems. This program contains four major research categories: freshwater ecological effects, marine ecological effects, and the Great Lakes and Chesapeake Bay programs. The total request for these programs in 1981 is $13.4 million and 155.9 permanent work years, a decrease of $1.8 million and 13.5 permanent work years over 1980.

The budget proposal for the freshwater ecological effects research program is $5.6 million and 88 permanent work years, which reflects an increase of $613,500 and a decrease of 10 permanent work years. The increase will allow a small increase of our wetlands research effort, and will enable ORD to produce important reports earlier than originally planned in support of the Clean Lakes demonstration program. Research to develop new data for water quality criteria documents will consume the remainder of the resource increase. The staffing decrease will shift some work to extramural effort.

The freshwater ecological effects program will be focused primarily on environmental exposure predictions and assessment, which includes in-stream and lake ecological effects and human food chain analyses; bioassay methods development in environmental toxicology; and the characterization of pollutants in biological materials. We will identify and continue to fill the remaining research data gaps for some of the 129 Consent Decree chemicals in support of the effort of the Agency to prepare Water Quality Criteria documents to comply with the Court's action.

We are planning to increase the freshwater wetlands research program in both resources and scope. The increase will be used to develop methodology for assessing the effects of pollutants on individual wetland plant species and wetland ecosystems.

The resources allocated for the fiscal 1981 Great Lakes program decrease by $2.0 million from fiscal year 1980, the result of the $2.0 million Congressional add-on in fiscal 1980 not being carried forward. The 1981 budget request is $1.6 million and 7 permanent work years. The program will continue activities underway in 1980, stressing studies on transport, fate, and effects of persistent toxic organic chemicals present in the Great Lakes.

The Marine ecological effects program will continue to emphasize research on aquatic toxicology in the areas of pollutant effects, bioaccumulation, methods to raise and maintain colonies of marine organisms, and analytical technique development; ocean disposal research will focus on the effects of municipal wastewater discharges through ocean outfalls; dredged material research will emphasize the development and validation of benthic bioassays and studies to determine the relationship between sediment contamination and other factors; and wetlands research will focus on questions of productivity and function.

The 1981 Chesapeake Bay Program will continue an integrated approach to research in the areas of toxic pollutant effects, submerged aquatic vegetation, and eutrophication. This includes development of predictive methods to assess the effects of pollutant loadings; development of a source assessment for toxic substances and nutrients entering the estuarine system from point and non-point sources; validation of transport and fate models for toxic substances, and evaluation of hazards to the ecosystem and to human health through the use of exposure effects models; and acquisition and synthesis of data to evaluate control options to halt eutropohication and major ecosystem changes such as the disappearance of submerged aquatic vegetation. The environmental management study will continue to evaluate existing management structures that influence decision processes affecting the Bay. Reports for toxics, submerged aquatic vegetation, eutrophication, and the environmental management study will be produced.

The data management system will be further developed to handle the data produced in the studies under this program and provide the basis for a centralized data bank for the Chesapeake Bay.

Pesticides

The pesticide ecological effects research program emphasizes assistance to the Agency concerning the registration/reregistration used in the formulation of policies and other decisions. Research studies encompass marine, freshwater and terrestrial ecosystems with impact assessments of organisms, populations and ecosystem interactions. Studies are designed to evaluate and predict the impact of commonly used pesticides, new generation chemicals, substitute or alternate compounds and their metabolites or degradation products. Research concentrates on the development, standardization and validation of an array of methods for assessing environmental exposure and effects which includes the transportation and fate of the pest control agent.

Continued priority research will include the testing and development of test methods and protocols for the RPAR chemicals with more emphasis on RPAR alternate compounds and with increases in testing for the registration process and registration standard process (generic standards) for decision making. This includes protocol development which can be utilized by industry for data generation. Hazard assessment will be an integral part of this program.

In fiscal 1981 the Pesticide Effects Research Program will be reduced by $264,100 and 8 permanent work years, for a total 1981 program of $2.4 million and 49 permanent work years. The decrease in funds for 1981 reflects a redirection of activities to engage in pesticide exposure assessment which will determine the concentrations of pesticides to which organisms and populations are exposed. This will allow a more complete analysis of risk/hazard potentials.

Toxic Substances

The goals of the 1981 toxic substances ecological effects program are to develop test methods for defining toxic effects of chemicals on organisms in the environment and ecosystem and to develop predictive tools and evaluate models for defining exposure concentration of chemicals in the ambient environment. Current emphasis is placed on the validation of test methods and models, development of multimedia models, food chain and exposure estimation, and for the screening of toxic chemicals by analyzing their chemical structures. This research will provide critical methodologies for defining hazard and exposure data for use in the implementation of Sections 4 and 5 of TSCA. An integrated program of laboratory and field studies aimed at providing an array of screening tests, models, monitoring approaches, and data bases which can be used to predict human exposures to substances once they are released to the environment will be continued under the Public Health Initiative - environment research program.

The FY 81 Budget represents an increase of $3.9 million and 19 permanent work years over the current level, for a total 1981 budget of $11.3 million and 44 permanent work years. This increase supports the implementation of several important initiatives planned in 1981: $944,400 and 19 permanent work years will be used to initiate a major ecological research program on aquatic toxicology with the objective of gaining a better understanding of the effects of toxic chemicals on ecosystem species and processes; $500,000 will support expansion of ongoing work on the development of monitoring methods for estimating human exposure to ambient toxics present in the environment; $1.0 million will provide for increased efforts to develop and to validate mathematical models for toxic chemicals; $1.0 million will support development of microcosms for screening and validation of models; and $500,000 will allow expanded efforts to predict the concentration of toxic chemicals in the food chain.

The expansion of the above research area and other work in ecological research will substantially increase our support to the Office of Pesticides and Toxic Substances. The above research will lead to the development of cost-effective and improved tests for defining the hazard of various toxic chemicals to the environment.

Energy

Ecological effects research within the interagency energy/environment program is oriented toward the assessment of the environmental effects of increased energy development on aquatic and terrestrial ecosystems. Activities include the identification of the ecological effects of chemical discharges from offshore oil and gas extraction and exploration; the development of techniques and user-oriented systems for the reclamation of coal and oil shale mining operations; and the determination of the environmental impacts of air and water pollutants from the use of energy generating facilities. Pollutants associated with these facilities, involving both conventional and emerging technologies, include leachates from coal and oil shale stockpiles; mining wastes; gaseous and particulate pollution from coal combustion; and wastewaters from cooling towers.

Research also includes the development and validation of test methodologies relevant to determining the ecological effects of energy-related pollutants. Testing techniques are used on bio-monitoring and assessment activities associated with the evaluation of environmental effects. The fiscal 1981 budget is $14.7 million and 4 permanent work years, a decrease of $666,000 and an increase of 1 permanent work year.

TRANSPORT AND FATE

The transport and fate research program develops analytical and empirical techniques relating pollution emissions to ambient exposure levels. We examine the biological, chemical, and physical phenomena affecting pollutants as they migrate from source to receptor, and determine their ultimate fate in the environment. This provides the basis for translating ambient environmental quality goals into pollutant control requirements at the source. This research also provides major input to our health effects research effort. Because of the chemical/physical transformation processes which occur in the natural environment, the actual agent causing health impacts may be different than would be suspected from identifying emissions and discharges at their source.

The transport and fate program is targeted to atmospheric, aquatic, and terrestrial pollutants, with activities in the air, water quality, toxics and energy media. The total request in 1981 for this program is $25.8 million and 89.4 permanent work years, an increase of $2.3 million and 23.0 permanent work years.

Air

The air transport and fate program identifies the sources, formation, transformation, removal processes, and ultimate repositories for air-borne gaseous and particulate pollutants. Using the data developed on these basic processes, we develop air quality simulation models which predict ambient exposure levels under various conditions and regulatory strategies.

The fiscal 1981 budget is $13.1 million and 42 permanent work years for this program, an increase of $487,600. This increase will support special studies to predict pollutant concentrations over complex or rough terrain, investigate the long-range oxidant transport phenomenon, study the role of man-made and natural sources of oxidants and hydrocarbons (oxidant precursors) and use smog chambers to simulate the photo-chemistry of oxidant formation in urban and rural atmospheric conditions. Work will be conducted on inhalable particulate matter, including sulfates, nitrates, and organics to determine their spatial and temporal concentrations in the air environment, their sources and sinks, and their contribution to visibility deterioration in various urban areas in the United States.

Water Quality

EPA's water quality transport and fate program provides methods and data to predict water quality impacts resulting from the discharge of point and nonpoint source pollution into fresh surface waters, to determine maximum allowable loadings of pollutants to a given water body segment, and to evaluate the costs and benefits of alternative management strategies. We emphasize developing procedures and mathematical models for assessment of water quality problems and pollution management strategies.

EPA Regional Offices and state and local planning and pollution control agencies use the outputs of the program to prepare water quality management plans for achieving and maintaining desired water quality goals, to provide wasteload allocations for nutrients and toxics, and to prepare justifications for contruction of advanced waste treatment (AWT) facilities. These methods and data also assist in the identification of both water quality limited stream segments and appropriate effluent limitations to be stipulated in National Pollutant Discharge Elimination System permits.

The proposed 1981 budget requests $1.3 million and 9 permanent work years. This is a decrease of $141,800 which will allow limited funding for a Water Quality Modeling Center addressing model technology transfer and model testing and evaluation.

Pesticide Environmental Exposure Assessment

Under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) EPA is required to carry out credible risk assessments and provide standard test protocols in the Pesticide Registration Guidelines. At present, neither adequate methodologies for exposure assessment nor standard protocols for transport and fate testing are available.

The New Pesticide Exposure Assessment Program includes the formulation of cost-effective, standardized protocols for generating data on the exposure concentration and testing of transport and fate of pesticides in air, water (freshwater and marine), soil, sediments, and biota. This will be accomplished by studies on: (1) measuring exposure concentration of 20 pesticides in air, freshwaters, estuaries, and coastal waters; (2) the bioaccumulation of these pesticides by biota; (3) their leaching from soils; (4) development of transport and fate testing protocols.

The major outputs of the program will be (1) exposure concentration and bioaccumulation data for 20 pesticides, and (2) protocols for the estimation of the volatilization, photolysis, hydrolysis, and microbial degradation of pesticides.

The 1981 resource level for Pesticide Environmental Exposure Assessment research will be $787,500 and 11 permanent work years.

Toxic Substances

The main research objective in 1981 for EPA's toxic substances transport and fate program is to develop standard and improved methodologies for estimating transport and transformation of toxic chemicals in air, water, soil, sediments, and biota. The 1981 budget provides $3.0 million and 25 permanent work years, an increase of $673,300 and 12 permanent work years over the current level. This increase will be used to (1) expand efforts to define rate parameters for transformation processes of toxic chemicals; (2) develop improved methodologies for describing quantitatively the transport and transformation of toxic chemicals in the environment; (3) develop advanced structure-activity concepts for predicting bioaccumulation and toxicity of chemicals to aquatic animals; (4) develop exposure assessment methodologies and testing protocols to be used in defining risk and hazard associated with toxic substances; and (5) develop the exposure assessment methodology to gain a more precise knowledge of the transport and transformation of toxic substances.

Expansion of the research efforts in this area will substantially enhance our support to the Office of Pesticides and Toxic Substances. The new research will lead to the development of cost-effective and rapid methodologies for evaluating risk, exposure and fate of toxic chemicals to human and the environment.

Energy

The energy-related transport and transformation program identifies the physical and chemical changes in pollutants from energy sources as they move through the air, to accumulate in the environment and to reach man. The goals of the program are to identify the sources and characterize emissions of pollutants and to model their distribution in the air, from both conventional and advanced energy technologies such as coal liquefaction and gasification, oil shale extraction, and geothermal energy development. Also included in the program is the determination of the rates and mechanisms of transformation of primary pollutants into secondary pollutants such as inhalable fine particulates, haze and acid rain by means of their interaction with ambient air, water vapor, cloud droplets, and solar irradiation.

The fiscal 1981 budget is $7.6 million and 3.0 permanent work years for this program, an increase of $450,700. This increase will be primarily allocated for modeling of pollutant dispersion at synfuel sites, including oil shale extraction. Also, increased emphasis will be on characterization and modeling of visibility impairing plumes of new coal-fired power plant constructions.

MONITORING AND TECHNICAL SUPPORT

Environmental regulation requires detailed, accurate knowledge of pollutant presence and concentrations in waste streams and in the ambient environment. The Agency's monitoring programs are designed to provide these environmental measurements. ORD's monitoring and technical support research program supports the environmental data requirements of the Agency through the development of analytical methods, systems and technology to measure pollutants at concentrations of interest to the regulatory programs. Further, this program includes the development of systems and procedures necessary to verify and assure data accuracy and precision.

The monitoring programs include the development of new methods and systems to meet new monitoring requirements, demonstration of these systems under field monitoring conditions, the provision of quality assurance tools and procedures to determine and verify accuracy of data and the provision of technical support to the regional and program offices.

We will establish a mandatory Quality Assurance (QA) program in fiscal year 1981 in response to a policy statement by the Administrator requiring participation in an Agency-wide Quality Assurance Program by all environmental data gathering organizations. The goal of this mandatory program is to assure that the precision and accuracy of environmental monitoring data can be documented. The FY 1981 budget request is $54.7 million and 391.8 permanent work years for the monitoring and technical support program. This represents an increase of $5.9 million and 3.5 permanent work years.

Air

The Agency's air monitoring and technical support program includes characterization and measurement methods development, monitoring methods and systems, quality assurance and technical support. The budget request for this program is $20.8 million and 155 permanent work years, an increase of $215,500 and a decrease of 6 permanent work years.

Of this, the 1981 budget request for the air characterization and measurement methods program provides an increase of $173,500 (for a total of $8.0 million). This increase will be used to help support a prototype study on the characterization of pollutants in the ambient air at urban locations and to identify the sources of any hazardous pollutants that are found. This effort will establish the basic requirements for the conduct of similar studies by other EPA offices and the States in their efforts to control hazardous pollutants in the atmosphere.

For the Monitoring Methods and Systems Program, a net increase of approximately $86,100 (for a total of $5.2 million) is requested. This increase will accelerate the implementation of the Inhalable Particulate Network. For Quality Assurance, the requested increase of $195,200 (for a total of $4.7 million) will accelerate the development and expansion of stationary source quality assurance efforts.

The Technical Support Program will decrease by approximately $239,300 (to a total of $3.0 million) and 3 permanent work years to accommodate shifting priorities in the Air Monitoring Programs. In FY-81, this program will concentrate on provision of support services to the Office of Air Quality Planning and Standards.

Water Quality

The Agency's Water Quality Monitoring and Technical Support Program encompasses characterization and measurement methods development, Monitoring Methods and Systems, Quality Assurance and Technical Support. The total request for this program is $12.1 million and 120 permanent work years, an decrease of $146,600 and 7 permanent work years.

Within this program, the fiscal 1981 budget for the water quality characterization program is essentially level. The program will continue efforts to develop techniques for measuring substances in waters, wastes, sludges, soils, and leachates.

The monitoring methods and systems program will decrease by approximately $334,900 and 7 positions (for a total '81 budget of $4.1 million and 60 permanent work years) to reflect a decreased emphasis on radionuclides and a reduction in research devoted to microbial measurement methods development. The quality assurance program budget request provides for an increase of $193,500 (for a total of $5.3 million) to expand support for toxic pollutant measurements.

The Technical Support Program focuses on the Agency's spill preventions and countermeasures program through the provision of field surveys and support for regional requirements. The total '81 budget request is $1.2 million and 9 permanent work years, an increase of $23,100.

Drinking Water

The drinking water quality assurance program focuses on supporting the Agency's drinking water monitoring program through the provision of standardized methods and quality assurance procedures and other services for operational use. The FY 1981 budget request for this program is $1.0 million and 10 permanent work years, essentially the same as the current levels.

Solid Waste

A key component of the Agency's budget initiative in hazardous waste will be the establishment of a program to develop new or improved sampling and analytical methods and validation procedures for hazardous waste identification in support of the Resource Conservation and Recovery Act, Section 3001 regulations. Included within this area will be the creation of a quality assurance program to assure the validity of all data generated.

In addition to these activities, which will be the cornerstone of the successful implementation of the RCRA 3001 regulations, there is a need for sampling, analytical, and monitoring methods and protocols to support the Agency's program for uncontrolled waste sites. The research program will also respond to these needs.

Our budget request for these activities for 1981 is $4.5 million and 17.0 permanent work years.

Pesticides

The pesticides quality assurance program serves to document the quality of physical, chemical and biological pesticides data in terms of precision and accuracy. In addition to providing standardized methodology, this program also includes development and maintenance of a repository of EPA certified reference materials for legal measurements performed by the Food and Drug Administration. The budget for this program is $565,400 and 12 permanent work years, essentially the same as in 1980.

Radiation

The radiation quality assurance was a new program during the fiscal 1980 budget year. Like the quality assurance programs in other media, this effort is dedicated to improvement of the accuracy and provision of radiation measurement. The program will provide calibration facilities and equipment, and conduct performance evaluation of laboratories conducting radiation measurements. The Agency requests a total of $191,100 and 5 permanent work years for this program in 1981, unchanged from last year's.

Toxic Substances

The Agency requests a total of $3.2 million and 26 permanent work years for components under this program, an increase of $558,900 and 4 permanent work years.

One of these components, the toxic substances characterization and measurement methods development program, provides improved methods to identify, quantify, and measure toxic chemicals in air, water, soil, sediments, plants and biota. These methods will enable the Agency to analyze new and existing toxic chemicals in the environment and to measure their concentrations.

The 1981 budget request for this program reflects an increase of $352,600 (for a total of $955,200). Of this increase, $75,000 will be used to expand the work on measurement methods for toxic chemicals in sediments, $127,000 will be used to initiate work on measurement of toxics in plants to validate food chain models and $150,000 will be used to initiate work on identifying and quantifying toxics in marine animals. The increased resources will enhance the ORD support to the Agency's program office and will provide the urgently needed strengthening of this area.

For the technical support program, the fiscal 1981 budget emphasis will be on field studies to validate models needed by the Agency's program offices to conduct assessments. The requested increase of $206,300 will be used to augment these field validation studies. The total '81 budget request is $2.3 million and 18 permanent work years, an increase of $206,300.

Interdisciplinary

The total budget request for the two components in this program is $2.9 million and 36 permanent work years for 1981. These figures are approximately the same as the current level.

The first component in this category, the technical information program, provides control coordination and quality control over the process whereby information generated by EPA's research program is provided to people and organizations both within and outside of EPA, who need that information in order to do their jobs.

Following a major study of all of ORD's technical information activities and nearly a year of analysis, discussion and review by ORD management, a major new technical information policy was inaugurated in 1980. The technical information program will provide centralized guidance for most of ORD's technical communications activities. All report printing, distribution and publications requests will henceforth be handled centrally. All seminars, workshops and conferences are now centrally monitored to assure cost-effective use of facilities and support. The production of peer-reviewed journal articles and reports is given impetus under the new policy, as is the effective packaging of information to meet the needs of the user community. In addition, the technical information program matches available research information, materials or technologies to the needs of officials who may not possess a scientific or technical background. The total 81 budget request is $2.7 million and 30 permanent work years, a decrease of $56,000.

The Workforce Development Program, the second component in this category, will decrease by approximately $55,700 and 2 permanent work years (for a total of $212,300 and 6 permanent work years) in fiscal year 1981 as a result of decreased emphasis on assessment of Agency needs in certification for environmental occupation in radiation, water quality and other areas. In fiscal year 1981, the management overview of the Agency's environmental workforce program and coordination of efforts with other Federal Agencies will be continued.

Energy

The energy-related monitoring program is directed toward developing the technology needed to characterize and monitor ambient air, water and groundwater pollutants from energy-related sources and toward obtaining data on environmental levels of these energy-related pollutants. The major research areas of this program are visibility, fine particulates, groundwater, exposure monitoring and offshore oil and gas drilling pollution.

The Fiscal Year 1981 budget provides an increase of $1.2 million over the FY-1980 level for a total program of $9.4 million and 10 permanent work years. This increase will be used to determine the correlation between fixed point ambient air monitoring data and actual human exposure to the energy-related pollutants SO2 and fine particulates. This will serve to evaluate how well data from a central monitoring station represent actual human exposure. In addition, this study will identify "hot spots" where pollutant concentrations are unacceptably high.

CONTROL TECHNOLOGY

Research on pollution technology and techniques is conducted in the industrial, urban or "public sector," and energy program areas. The FY 81 budget request for the control technology program is $125.3 million and 442.8 permanent work years, an increase of $10.5 million and 12.4 permanent work years.

The energy portion of the program assesses the potential for environmental insult associated with conventional as well as emerging energy technologies. This program evaluates the degree of control needed to reduce the potential impact of pollution and assesses costs associated with various pollution abatement technologies. Results of this research are utilized by the Agency's regulatory program to develop standards of performance, effluent guidelines, and waste disposal practices for activities concerned with energy production, such as for use by the private and public sector to expand the use of coal while minimizing associated environmental insults.

The industrial component develops and evaluates technologies to reduce pollution from manufacturing, agricultural and service industries, and from the extraction and processing of non-energy-related raw materials. We place high priority on the elimination or control of toxic pollutants and on devising ways to reuse wastewater for industrial purposes. Through this program, we develop ways to reduce the release of pollutants from both point and nonpoint sources and to control spills of hazardous materials. The results of this research also support the development of New Source Performance Standards and effluent guidelines.

The third component of the Control Technology program, the urban or "public sector" research area, develops technology to improve municipal wastewater treatment systems, determines suitable means of managing urban runoff, develops technology to disinfect or decontaminate drinking water supplies and develops technology for solid and hazardous waste disposal. These activities support the Agency's strategy for achieving the goals of the Clean Water Act, and EPA's regulatory efforts under the Safe Drinking Water and Resource Conservation and Recovery Acts.

INDUSTRIAL PROCESSES

The total budget request for 1981 for industrial processes is $20 million and 72.6 permanent work years. This represents a decrease of $4.0 million and 14.0 permanent work years, primarily in the pesticides and water quality areas, described below.

Air Industrial Processes

The air control technology program is executed primarily as an extramural effort responsive to legislative mandates of the Clean Air Act. Our objective is to develop and demonstrate pollution control technologies capable of reducing or eliminating potentially hazardous air pollutant emissions from industrial point sources. The program provides technical and cost information to the regulatory offices of the Agency to assist in the preparation of additional New Source Performance Standards in the enforcement of existing standards.

The program focuses on those critical emissions known to have detrimental effects on human health and the environment--such as hydrocarbon emissions from volatile organic chemicals, which are precursors to oxidant formation. Also, to accelerate acceptance of new technology, we demonstrate the applicability of techniques such as control of solvent emissions in the dry cleaning industry. Industries under study include chemical processing, agrichemicals, textiles, pulp and paper, metal fabrication and finishing, metal and mineral production, petrochemical storage and refining. Air emissions resulting from hazardous materials incidents are receiving increased attention.

Water Quality Industrial Processes

The water quality industrial research program encompasses development and demonstration of new or improved, cost-effective technologies and practical management systems for industrial, agricultural, and sulvicultural production activities.

As a result of the EPA/Natural Resources Defense Council Consent Decree in June 1976, and the 1977 Amendments to the Clean Water Act, the current industrial program emphasis is on developing the data required to regulate the discharge of toxic pollutants. The program focuses on developing complete waste stream assessments, which include chemical and bioassay data, and on developing treatment alternatives for industrial waste effluents. In addition, this program develops technology for the prevention and control of accidental spills of hazardous materials.

In FY 81, we will continue our efforts to optimize currently available treatment method and on developing innovative technologies to abate, destroy or beneficially reuse pollutants.

Special emphasis will be placed on developing a treatability research program that defines the extent to which existing and new technology can be applied to treating toxic pollutants. This data is used to assist the Effluent Guidelines Division in the preparation of regulations and to provide a basis for the writing of permits in situations not covered by existing regulations. 1981 funding in this area will allow limited innovative technology development and the extension of available treatability data for toxic pollutants.

The program, initiated in 1980, for the demonstration of reuse and recycle options for industrial wastewater discharges will be continued at a high level. Background studies in specific industrial areas will be completed and pilot plants will follow or demonstration scale projects will follow, when appropriate. Development efforts underway will yield the necessary data for the implementation of full scale industrial wastewater reuse/recycle systems. Reuse/recycle studies will by initiated in industrial areas other than those currently under study.

As in previous years, the hazardous incident program will continue the development of control technology in support of regulatory needs for control, cleanup and removal of toxic and hazardous spills and for restoration of impacted lands and waters.

The water quality program on renewable resources has examined the pollutant contributions from nonpoint agricultural activities and has evaluated certain farming practices for their pollution control potential. Other studies have developed mathematical models which would be useful in predicting the effects of alternative agricultural management practices. This program will decrease by $2.5 million and 14 permanent work years, resulting in discontinuation of extramural research on Best Management Practices (BMP's). This reduction was based on factors including the availability of some BMP's in Sec. 208 plans and the phaseout of the program at the end of 1983; problems with implementing existing BMP's; and the level of resources at USDA directed to BMP's. With a reduced budget for FY 81 of $319,300 and 10 permanent work years, the program will maintain a minimum level of technical assistance for the EPA Program and Regional Offices.

Pesticides

The Integrated Pest Management (IPM) research program (Section 20(a), FIFRA) supports the development of alternate pest management control tactics and strategies for agricultural and urban pests. Using a systems approach, IPM strategies are designed to effectively utilize alternative biological and cultural practices to reduce the reliance on chemical pesticides.

The current program continues the multi-agency, multi-year, multidisciplinary IPM research program for corn, cotton, soybean, alfalfa, apples and rice/mosquito ecosystems authorized by Congress in FY 79. These "consortium - type" projects bring together a breadth of disciplines and the best expertise available among participating universities and federal scientists to work on major pest complexes (insects, weeds, diseases) on the six crop production systems.

Accomplishments expected to be achieved by this research include:

(a) alternative non-chemical methods of pest control;

(b) methods for using chemical pesticides in a more selective, judicious, economical and environmentally compatible manner;

(c) computerized integrative models for optimizing crop management and pest control practices;

(d) economic analysis of each new crop-pest management program;

(e) identification and characterization of new agents for pest control;

(f) basic studies on pest population dynamics, interactions of pests with hosts and natural enemies, dispersion and migration, dormancy, behavior, and biotic and abiotic factors affecting survival and rates of increase;

(g) training of pest management specialists and decision-makers;

(h) IPM demonstration areas in cooperation with extension personnel to illustrate the practicality and economic benefits of integrated pest management to farmers; and

(i) optimal crop-pest management systems.

Major progress has been achieved in correcting past institutional barriers, within EPA and with other Federal Agencies, which have delayed the implementation of an effective IPM program. The IPM research program is being integrated with (a) EPA's pesticide registration and re-registration procedures; (b) EPA's related pesticides health, ecology, quality assurance, and exposure work; and the pesticides water quality research programs; (c) the USDA-Science and Educational Administration (SEA) IPM research, extension, and education programs through a proposed coordination and communications plan and (d) other Federal agencies involved in the development of an Urban IPM Research and Implementation Plan, to study urban pests in households, gardens, lawns and trees.

In FY 81, EPA and USDA-SEA will jointly fund and manage the 15-University Consortium Project working on cotton, alfalfa, apples and soybean IPM systems. Joint management and review teams will be established to coordinate EPA's IPM research with SEA's IPM Regional Projects. EPA, in conjunction with other federal agencies, will implement an urban IPM research and implementation program in FY 81.

The EPA IPM research program will be reduced by $986,000 in FY 81. However, this reduction is offset by the USDA-SEA agreement to provide $1.5 million of the $3.0 million required to fund the 15-University Consortium Project. Consequently, the IPM research program will, in effect, have a net gain of $514,000 in FY 81. These resources will assure that IPM mosquito control strategies are integrated into holistic rice production IPM programs.

Toxic Industrial Processes

The toxic substances industrial research program, now in its third year, supports directly the current needs of the EPA Office of Pesticides and Toxic Substances. The program provides (1) technical assistance relating to toxic identification and quantification for industrial manufacturing processes and products; (2) evaluations of process alternatives in terms of environmental acceptability based on toxic pollutant criteria; (3) definition of the occurrence of toxic substances as impurities in commercially available chemicals from a knowledge of process chemistry and waste composition; and (4) provision of technical assistance in terms of participation in working groups, review of reports and documents.

FY 1981 activities will increase by $123,900 for a total program of $1.8 million and 11 permanent work years. This supports the Agency program office's need to continue the new chemical manufacturing pollution predictive model based on the unit process approach. The model will include: (1) anticipated processes in manufacturing of products, (2) expected environmental releases associated with processes including quality and quantity, (3) recommended control methods, and (4) risk analysis relative to feedstocks, by-products, impurities and degradation products.

PUBLIC SECTOR PROGRAM

As noted earlier, our Control Technology program also addresses pollution problems associated with urban or "public sector" activities--treatment and disposal of municipal wastewater, provision of safe drinking water, and disposal of solid waste and hazardous materials. The 1981 total budget request for these activities is $47.8 million and 239.3 permanent work years, an increase of $9.4 million and 30.7 work years.

Wastewater

In the municipal wastewater area, we develop cost effective technology for treating and disposing of wastewater and sludge. This program addresses the research needs of construction grants, Section 208 areawide planning, toxic pollutants control, permits and enforcement, Clean Lakes program and non-point sources programs. It develops new treatment processes which are efficient, reliable, energy conservative, and economical. Our main focus will continue to be on sludge disposal, toxic pollutants control, and support of the innovative and alternative technology program for construction grants. Our FY 81 request provides for a decrease of $128,700. The net decrease is the result of: a decrease of $601,500 eliminating work in aquaculture and development of alternative disinfection processes, and an increase of $472,800 to support a very limited number of evaluations of innovative technologies built with construction grants.

We will continue efforts on data collection on the levels of toxic pollutants which may be in municipal wastewaters. This information will help in other studies underway which involve indentifying and solving pretreatment and combined treatment problems. Our ultimate goal is to provide the technology and management options so that the presence of toxic pollutants can be minimized.

Drinking Water

The drinking water research program provides methods for identifying and measuring contaminants in drinking water, and develops, evaluates, and improves the control technology necessary for achieving drinking water standards at reasonable cost. We also perform research to establish a scientific base for regulatory decisions to protect ground water sources of drinking water. Total funding requested for 1981 is $14.1 million and 78 permanent work years, an increase of $4.3 million and 10 permanent work years.

Our research on treatment methods concentrates on organics with emphasis on full-scale treatment processes. In addition, we work on methods to control inorganics, particulates and microbiological contaminants with attention to treatment costs. Distribution system effects on inorganic and microbiological quality of drinking water are also studied.

In the ground water protection research area, efforts are directed toward providing (1) assessment methods for determining ground water contamination, (2) methods for determining and predicting the adsorption, movement, and transformation of contaminants in the subsurface (especially organic chemicals and viruses), and (3) the scientific data for regulatory decision-making on specific sources of potential ground water contamination. Information transfer is also important, and typically a large part of the resources are expended in technical assistance.

Later this year the ground water research area will be modified as appropriate to provide the scientific bases for implementing the Agency ground water strategy currently under development. This might, for instance, involve supporting the preparation of manuals which describe the kinds of data available and the decisions required for development of aquifer management plans by state and local governments. Alternatively, the research might be directed toward more intensive development of ground water investigation methodologies.

The increase in FY 81 of $4.3 million and 10 permanent work years is requested in developing information to assist small communities in meeting the national and state drinking water standards. Small towns (pop. under 10,000) comprise 80 to 90 percent of all drinking water systems and regularly serve approximately 20 percent of the U.S. population. This research is needed because small systems have disproportionately more incidences of contamination than larger systems, in part because they cannot afford the large-scale technology used by systems with more customers.

EPA proposes a program to (1) develop information on cost effective technology for small systems; (2) provide cost data and information on treatment methods usable by small towns; (3) develop an administrative pilot program of multi-community cooperative arrangements under which a number of communities establish a common source for services or can enter into an agreement with public or private organizations to provide such services; and (4) evaluate treatment systems and unit processes to determine whether or not they are amenable to certification by non-government organizations and under what circumstances certification would be meaningful. Such certification would provide valuable guidance to the small towns and the system designers in selecting treatment methods.

At the same time the program will move forward to develop information on economical treatment processes to control specific compounds of health concern which are discharged into and are found in our drinking water sources. Efforts will be made to produce, evaluate and bring together information on the performance of existing field scale units producing drinking water from questionable or suspect sources. The evaluations will include cost data and information on effects on microbiological quality.

Solid/Hazardous Waste

The purpose of the solid and hazardous waste research program is to ensure that there are adequate environmentally sound practices for solid and hazardous waste disposal to prevent air and water pollution, eliminate hazards to health, and conserve land and other natural resources. To this purpose, the research program supports the Agency's strategy for achieving the goals of the Resource Conservation and Recovery Act of 1976 (RCRA).

Until recently, the major emphasis in this research program had been non-hazardous (municipal) wastes. The effort was geared primarily towards solving landfill design and operating problems and reviewing and studying resource recovery from municipal solid waste. After the passage of RCRA, the research program was redirected to place more emphasis on hazardous waste. In fiscal year 1980, 80 percent of the research program addresses the problems of hazardous waste and in fiscal year 1981, it will be over 95 percent.

The Agency requests a total of $18.9 million and 50 permanent work years for the control technology component of this program, an increase of $5.2 million and 30 permanent work years. The major areas of emphasis in the control technology program for fiscal year 1981 will be in technologies for hazardous waste destruction, land disposal, and remedial action. Some work will continue in the resource recovery area; however, this work will emphasize hazardous waste. Municipal landfill design and resource recovery activities will be phased out.

Two major means that will be used for the disposal of hazardous wastes are destruction by incineration and land disposal.

Therefore, the Agency needs to permit these facilities. The research program on hazardous waste destruction will be greatly expanded to more rapidly improve the information base necessary to write permits for incineration. The ultimate product will be a series of manuals which will be continuously updated and improved by the research program in the future. This is necessary because the Agency's capacity to assess the capability of incinerators to destroy hazardous wastes is rudimentary at best. Nevertheless, incineration—and thus the destruction of many of the organic hazardous waste is probably the preferable and perhaps the only safe approach to the disposal of the wastes.

The land disposal research will continue the effort begun in 1980 to publish manuals for permit writers. Research results and data on landfill containment, fixation, liners, covers and other aspects of land disposal technology will be the basis for environmental permits issued to hazardous waste disposal facilities.

Although the Agency emphasis is initially on investigation of sites, it will shift to the clean-up of sites as enforcement actions arise or when the superfund legislation becomes effective. To meet these future needs, the research program is expanding its efforts in remedial action technology development.

High priority will be given to producing useful field data for use of the Agency in its clean-up program. Actual remedial schemes will be implemented at the field sites on Federal land and will emphasize demonstrations of control of runoff to surface water, migration into groundwater and chemical immobilization.

The research programs in industrial waste resource conservation and recovery and in hazardous waste treatment will continue at a constant level of activity. The treatment technologies being investigated include those for neutralization, bio-degradation, detoxification and fixation.

ENERGY PROGRAM

The energy control technology program will allow for studies of the expanded use of coal in utility and industrial power generation facilities and the development of a synthetic fuels industry in an environmentally acceptable manner. The FY 81 budget request for this program is $57.5 million and 130.9 permanent work years, an increase of $5.0 million and a decrease of 4.3 permanent work years.

This program includes the development and assessment of control technologies which, if successful, will reduce the real cost of particulate, NOx and SOx control for utility and industrial boilers.

For particulate control, we have developed an electrostatic precipitator precharger which has successfully concluded pilot scale testing. The pilot scale results indicate that a factor-of-two reduction in the capital costs for controlling particulate emissions from the combustion of low sulfur coal may be achievable. Continued experimentation at prototype scale is planned. If the results warrant, a full scale demonstration of this improvement will be initiated.

The combination of SOx and NOx control into a potentially low cost system is a possibility in the mid-term future if the results of our research continue to be favorable. EPA has developed a pulverized coal burner which can lower NOx emissions by 80-95 percent from uncontrolled levels. This burner has been demonstrated at utility boiler burner scale and industrial boiler burner scale. In FY 80 and 81, demonstrations of this burner on two commercial industrial boilers and one utility boiler will begin. This demonstration program is planned to last for 18 months.

A significant breakthrough in SO2 control based upon this low NOx burner may be possible. When limestone is added to the coal prior to pulverization and the pulverized mixture burned in the low NOx burner, sulfur oxide emission reductions have been observed. In preliminary tests, SOx reductions of up to 88 percent have been reported. These results are preliminary, but EPA is accelerating the developmental schedule to take advantage of potentially significantly lower SOx control costs.

The potential economic impact of these EPA breakthroughs can be readily seen. The environmental control cost to comply with the existing Utility Boiler Standards of Performance could be lowered from $152/kw to $53/kw for low sulfur coal and from $158/kw to $48/kw for high sulfur coal. This economic benefit would occur without sacrificing environmental quality.

The synthetic fuels area is being expanded in response to the national effort to develop the new, emerging synthetic fuels technologies as quickly as possible. ORD is coordinating an Agency effort to prepare Pollution Control Guidance Documents during 1981. Our current plans provide for the issuance of these documents for oil shale, low BTU coal gasification, high BTU coal gasification and coal liquefaction. The purpose of these documents is to provide guidance to the permitting officials in the Regions and states and to the industry on the best available pollution control technology suitable for use on a particular waste stream and the costs associated with this treatment. For each technology the document will provide:

- o A description of the process being considered.
- o Characterization and quantification of waste streams associated with the process.
- o A description of pollution control technology currently available to handle waste streams.
- o Costs of these technologies.

In addition to the guidance document development effort, the R&D program will provide the data required to allow the Agency to promulgate air, water and solid waste regulations for these industries at a later date.

ANTICIPATORY RESEARCH

This program was initiated in fiscal 1978 in response to concerns of the National Academy of Sciences and the Congress that EPA was not conducting enough research of a long-term nature or enough research on newly emerging problems. It serves as a focal point within EPA for implementing the President's basic research initiative, for identifying and assessing new problems and for developing fundamental understanding needed to make better informed judgments in the future. The fiscal 1981 budget for this activity provides continued support for Anticipatory Research's Center Support, Special Studies, and Innovative Research Programs. The budget request is $14.7 million, essentially the same as last year's; and 58 permanent work years, a decrease of 20 permanent work yers.

The Center Support Program provides long-term support for exploratory research in areas particularly critical to EPA's mission. This Program is conducted at leading scientific institutions throughout the country. During 1979, we established three institutional centers in the following areas: Epidemiology at the University of Pittsburg; Advanced Control Technology at the University of Illinois; and Groundwater Research with a consortium of universities which includes the University of Oklahoma, Oklahoma State University, and Rice University. In fiscal 1980, we expanded this effort to include Centers for Intermedia Transport, Ultimate Waste Elimination, Ecosystem Studies, and Marine Research (which has been established at the University of Rhode Island). We hope through these efforts to establish long-term research into fundamental problems and to further develop our relationships with the outside scientific community by taking advantage of the excellent talent available at various institutions. In fiscal 1981, management focus will aim to assure that the Centers contribute significantly to the quality of science and an enhancement of knowledge within key environmental problem areas. For these activities, we are requesting funding of $3.2 million.

In fiscal 1981, the budget also provides for the continuation of our Special Studies Program. The purpose of a special study is to broaden the appropriate data bases within areas where potential future environmental problems have been identified but for which further research is needed to determine the actual scope and significance. A special study may also serve as a highly visible core or integrating component of a major ORD-wide multidisciplinary research effort. Current special studies include: Acid Rain, Biomonitoring, Cancer Research, Environmental Benefits and Forecasting.

Our acid rain studies, begun in FY-79 to assess the national impact of acid precipitation, will continue as a key component of the President's proposed interagency acid rain program. The management focus and resources provided by the Anticipatory Program for acid rain studies will be supplemented with redirected activities in our energy program to produce an integrated and expanded commitment. In FY-81, we will continue cooperation with scientists in other countries and we will work with USDA, DOE, NOAA, and other agencies to improve monitoring programs, to map and identify areas sensitive to acid rain, to quantify the effects on crops, lakes, soils, forests, and drinking water and to develop understanding and models to predict the deposition of acidic materials.

The object of our Biomonitoring Study is to evaluate the utility of biological indicators as tools for discovering latent or future threatening environmental quality problems. The core element of this special study is the Mussel Watch Program, a long-term effort to monitor chemical residues and physiological responses in the Nation's coastal waters. In FY-81, the Mussel Watch Program will conduct its fourth nationwide sampling and analysis to determine any long-term trends in the health of our coastlines. Also in 1981, pilot terrestrial and freshwater biomonitoring efforts initiated in FY 1980 will continue so that a full assessment of their utility in a nationwide effort can be conducted.

Our Cancer Research Special Study is a multidisciplinary effort aimed at increasing our understanding of the linkages between environmental carcinogen exposures and cancer incidence in the general population. In FY 1981, a field study, initiated in FY 1980 to test and evaluate newly developed integrated exposure and health assessment techniques and concepts, will be continued and unique indicators for detecting carcinogens in the environment will be evaluated.

The Environmental Benefits Special Study strives to improve our capabilities to assess the economic benefits of pollution control regulations and programs. In 1981, we plan to continue efforts to develop measures of the economic benefits of improved visibility in both western national parks and on the East Coast. Also major results are expected from our efforts in developing quantifiable methods for the health benefits derived from air quality control and aesthetic benefits of water pollution control.

In fiscal 1981, we will expand our Forecasting Special Study activities. We believe strongly that improvements can be made in our ability to identify trends likely to have significant environmental consequences in the future. Special analytical studies of the long-term impacts of the actions of other government agencies, and of social and industrial trends, will be part of this effort. The results will be assembled in the Environmental Outlook Report and will play an important role in helping us identify areas of exploratory research to be pursued through our Center Support Programs, Special Studies Programs, and Innovative Research Program.

Finally, in the Innovative Research Program, we continue to provide opportunities for individual scientists in and out of the Agency to conduct fundamental environmental research. During 1979, we initiated within the Agency, a competitive procedure which allows our own scientists to submit proposals for the conduct of basic research. These proposals were reviewed by outside experts and a limited number were selected. We believe this kind of opportunity will allow our own researchers to explore new scientific areas of concern to EPA at minimal cost. In FY-80, we supplemented this program by providing support for outside scientists in new areas of genetic engineering, toxic pollutant impacts on wildlife, and the impacts of pollution on the aged individuals of our society. In FY-81, we are seeking level support for these activities, although the emphasis will change to include new exploratory areas identified through our Forecasting Special Study.

Overall, the fiscal 1981 budget calls for a decrease of 20 positions. The decrease in positions reflects the transfer of several activities to the toxic substances media. Anticipatory Research efforts in the areas of transport, fate and effects of toxic pollutants have reached a point where association with the strategies and programs of the toxics medium is now appropriate.

Thank you, Mr. Chairman. This concludes my prepared statement.

Dr. **Reznek**. Thank you, Mr. Chairman, members of the committee.

The purpose of the Office of Environmental Engineering and Technology is twofold: First, we create and then accelerate the implementation of new, improved or less costly pollution control technologies; and, second, we provide sound engineering information on which to base EPA's regulatory actions.

I would like to talk about four selected areas. They don't exhaust everything in my program, but they are areas of great activity. These four areas are coal combustion, synthetic fuels, drinking water, and hazardous waste.

A technology is needed to remove the pollutant sulfur dioxide from combustion gases, particularly, the flue gas of coal.

The most common technology is limestone scrubbing. This is a picture of the EPA-owned pilot plant with three 10-megawatt units for limestone scrubbing.

Chairman **Ambro**. Excuse me a minute. Do we have your statement before us?

Dr. **Reznek**. There is no written statement.

The technique is to introduce a slurry of powdered limestone in the top of the reaction chamber and blow the flue gas up through it. The sulfur dioxide and flue gas react with the limestone and the sulfur dioxide is removed.

This pilot plant has been the major source of information and data in designing the 45 operating units now being used around the country and some 40 units which are currently under construction.

The data from this unit and from those commercial units have provided a basis of new source performance standards for coal combustion under the Clean Air Act.

Chairman **Ambro**. What do you mean by that?

Dr. **Reznek**. The EPA has established the standard to be 90 percent removal for high-sulfur coals and 70 percent removal for western low-sulfur coals. The background documents to go into such a decision are extremely voluminous. There are a number of studies. I think the agency spent $15 million preparing all of the information. Our part in that activity is to document the performance of the technologies that actually exist in the field and to develop a method for deciding on the engineering cost of that technology. Those documents are part of the record and are subject to close cross-examination. They provide the engineering data on which the standard is based.

The additional part of that standard which we did not anticipate is the economic impact of meeting those costs.

Chairman **Ambro**. Did you say that pilot represents three 10-megawatt plants?

Dr. **Reznek**. Yes; those are three side-by-side 10-megawatt units.

Chairman **Ambro**. What does that cost?

Dr. **Reznek**. I believe the total cost over the years probably approaches $10 million. Now I would think the construction costs are probably $3 to $3½ million, and then the testing program would assume the rest of it. I can supply the numbers.

Chairman **Ambro**. That is for each 10-megawatt plant?

Dr. **Reznek**. No; the whole three units.

Chairman AMBRO. What application do you think that has? Do you think you can use that technology for the basis of providing the desulfurization in coal-fired plants that have been ordered to convert from oil and gas combustion?

Dr. REZNEK. Yes, sir, both for new plants and for conversions where they will have to use coal and add a desulfurization technology.

This plant has been very productive. The data from these three side-by-side 10-megawatt units are the basic data being used by the companies that supply limestone scrubbing and by the designers. This Government-sponsored facility has produced the basic design data that are now being replicated. There are 45 units across the country operating today and another 40 under construction. Those units are basically designed on the engineering data that came out of this facility.

Chairman AMBRO. What 40 units are under construction; are they in the utility or private sector?

Dr. REZNEK. Utility.

Chairman AMBRO. What is the size on average of those plants?

Dr. REZNEK. The largest one that I know of is 830 megawatts. Most of them run in the 200-megawatt size.

Chairman AMBRO. What is the cost of a desulfurization system like this in a 200-megawatt plant?

Dr. REZNEK. The capital cost is about $120 a kilowatt. So for a 200 megawatt, it is $24 million.

Chairman AMBRO. Well, that is about 1,000 percent under the cost estimation that we got for the installation of pollution control equipment. For example, for a plant a little larger than that, the estimate that we got was $200 million. Because the list for the coal conversion order on the east coast applies to practically every utility company, the cost would have a horrendous impact on rate payers. For example, to install these systems in a 1,400 megawatt plant would cost $800 million according to the utility companies. We will talk about this issue later so let us move on.

Dr. REZNEK. The range of capital costs in the order of $120 per kilowatt capacity is a number which has received intense review by the Agency.

Chairman AMBRO. Would it cost more to retrofit rather than to build from scratch? Is that what we are saying here?

Dr. REZNEK. It could. If you have a plant that used to burn coal that has been ordered to convert and has given up its space, it has no place to build units such as this and it has to acquire new property. If that property is expensive, it could be a horrendous cost.

Chairman AMBRO. I'm not referring to property costs, just capital costs. What is the difference between retrofit and building a new system?

Dr. REZNEK. The retrofit cost may be slightly greater. If you are designing a new plant you will have a plant lifetime to depreciate the cost of this piece of capital. If you are retrofitting a plant that is halfway through its lifetime, or two-thirds the way through its lifetime, then you have to depreciate this capital in a much shorter period. In this case the annual expense of paying off that capital is certainly much higher.

Chairman **Ambro**. One last question. If you are using coal, let's just pick a figure of 10,000 tons a day, what would be the approximate amount of residue generated from a system like this? Would it be 3,500 tons a day?

Dr. **Reznek**. 10,000 tons a day?

Chairman **Ambro**. Yes.

Dr. **Reznek**. A quick calculation, it is 20 percent the weight of the coal for both flue gas desulfurization and ash. I get 2,000. So it is 2,000 to 3,000 tons a day.

Chairman **Ambro**. We will talk later about this, not only between the economics involved, but the environmental impact of disposing of this. I am sure you are prepared for that.

Dr. **Reznek**. The weight of the disposable material associated with flue gas desulfurization is approximately equal to the weight of the ash in the average eastern coal. So you are doubling your disposal problem.

This is one of our discoveries which we think is going to help reduce the cost of desulfurization. This is a result of a chemical which we discovered as an additive. It controls the chemistry within that reaction chamber.

Without the additive, limestone scrubbing, under the conditions at which we were operating the test facility, was removing about 90 percent of the sulfur and the variability in performance was quite high.

When the chemical additive is added, performance is increased up to 97 percent under the same design and operating conditions. The variability is markedly decreased. We believe that the use of this chemical additive, adipic acid, will lower the overall cost by about 7 percent.

Another technology that we are extremely excited about is applicable to western low-sulfur coals. This technology we call dry scrubbing. The heat of the flue gas is used to completely evaporate slurry, and what is left is in the form of the dry particulate.

We think that dry scrubbing will result in about 30-percent cost reduction. Congress, also, was very interested in this technology and increased our fiscal year 1980 appropriations by about $1 million.

This is a flame pattern for a rather large burner. EPA's research on the control of nitrogent oxides has been advanced by improving the burner designs to give us a series of combustion stages that create the best conditions for fuel-to-air mixtures and operating temperatures.

The improved designs in the combustors reduce nitrogen oxide emissions by 85 percent and can actually improve operating efficiency and lower the cost under certain conditions.

This is a diagram of the operation of our combustor design. Rather than mixing all of the air and the fuel and injecting it into the flame area, we staged the introduction of the air by removing some of the combustion air from the center of the flame. That air mixes later. We create, first, a fuel-rich area and then finally a completed combustion area. That flame design reduces the production of nitrogen oxide.

We are very excited because this technology which will be very inexpensive or sometimes realize a slight cost saving, can remove 85 percent of the nitrogen oxide.

I would like now to expand a little bit on Dr. Gage's remarks about the synthetic fuels area.

This is a pilot plant under construction that will turn coal into a synthetic crude petroleum. We will be evaluating its environmental performance.

The purpose of the engineering program in synthetic fuels is to produce what we are calling environmental pollution control guidance documents for synthetic and alternative fuel facilities. These documents will describe the processes and the pollutants they generate. Each document will, also, present our current estimation of the capabilities and costs of the controls for these pollutant releases.

The pollution control guidance document will provide the basis for permitting these facilities and establishing performance requirements under the Clean Air Act, the Clean Water Act, the Resource Conservation Recovery Act, and the Toxic Substances Control Act. EPA will produce a single statement about all the environmental requirements on a facility.

High quality documents developed on a timely basis can stabilize the development of this important emerging industry. The greatest barrier to the development of synthetic fuels is uncertainty, and environmental requirements are certainly one source of uncertainty.

The guidance documents will clearly describe the controls that are needed, what we estimate their cost to be, and what levels of performance we estimate they will obtain.

The documents will also expedite the permitting, by both local, State, and Federal agencies.

The third area I would like to discuss just brieflly is drinking water.

Chlorinated compounds are found in drinking water supplies and carbon absorption can remove these materials. Carbon absorption is, unfortunately, expensive. We are in the research program looking at ways to reduce the cost of carbon absorption. Two methods have proved promising: One, is by extending the lifetime by adding ozone prior to the carbon absorption. This helps destroy the organics that build up on the carbon while the system is in place and functioning. The second area where we have had some success is to reduce the cost of regeneration of the carbon. Under the traditional approach, carbon is regenerated at high-temperature facilities, which not only are expensive, but lower the lifetime of the carbon. We have been experimenting with a desorption technique to strip the organics off the carbon.

In 1981, we are going to be expanding in the area of small-flow systems. Our program in this area will not be hardware oriented. It will deal with changes in the management, control and understanding of small-flow systems. For example, we may try circuit-rider concent where a single highly trained individual could visit a series of supply systems and try to improve their performance. With experiments on better monitoring and instrumentation, for example, which will allow the operators to understand their performance, we are hoping that we can provide improved performance for an important part of the drinking water supply system of the country.

The last area I would like to talk about is the area of hazardous waste. This was a fire that took place in an improperly managed storage and disposal facility, handling the very high toxic waste residues from the manufacturing of pesticides. EPA has a national response team to respond to such facilities. The research program has developed its equipment and its operating procedure. This is a team responding to the investigation of a poorly-operated site. Their equipment, protective devices and sampling analysis equipment were developed by the R. & D. program.

This slide shows an improperly managed waste disposal facility outside of Oswego, N.Y. The toxic materials from chemical manufacturing have been dumped into lagoons. Drums containing highly toxic materials have been stored in the open. Many of those drums are rusted and leaking.

The toxic materials stored either in lagoons or on site are reaching surface and groundwaters and generally escaping the site.

The blue things in the corner of the slide are some EPA developed cleanup devices. This is a picture of that device. It is a portable on scene capability to absorb toxic materials out of water and to dispose of them. This technology—the large three cylinders—is carbon absorption.

This technology has been replicated now in the private sector. There are firms who have the capability to respond to sites like this as a marketable service. The designs of their equipment are based on this trial unit.

The Office of Research and Development does not operate this unit now that we have approved it. It is in the hands of our operating program.

That summarizes some of the highlights of the engineering program. Thank you.

Chairman Ambro. Dr. Reznek, just let me ask you a question. Did you say that, in your small-flow systems program, you are going to increase personnel?

Dr. Reznek. Yes; there are 10 additional positions associated with that initiative.

Chairman Ambro. How much does that represent in dollars?

Dr. Reznek. About $4.25 million.

Chairman Ambro. And you say that these people will visit the sources of supply and review performance and monitor and look at management, and things of that nature?

Dr. Reznek. No.

Chairman Ambro. What will they do?

Dr. Reznek. They will be basically in the contract management mode.

Chairman Ambro. What do you mean? What is a contract management mode?

Dr. Reznek. Their job is to let contracts for research or to make demonstration grants. They monitor the progress and the performance of these contracts and grants.

The actual field research work will not be done by Federal employees.

Chairman Ambro. They will advise municipal water suppliers of how they can get money to develop control technology from the Federal Government through its programs; is that what you are saying?

Dr. Reznek. As a part of this program, we will attempt to find an area of the country to do a demonstration of the improvements in performance that can be achieved by institutional change. This would be for several small communities, each of which have operated independently, to go together either in terms of hiring an expert or establishing a central laboratory and testing facility. We will contract and help subsidize the demonstration of the advantages that can be obtained by such a region. So we would end up making a grant or contracting with several municipalities that would jointly fund the development of a laboratory and the hiring of an expert to provide advice to the operators of their individual treatment facilities. We would document the improvement in drinking water quality achieved through such an arrangement.

There are other things that we will be doing. We will develop manuals that the operators at such drinking water facilities could use in evaluating the performance of systems that they are considering buying. The only thing they now receive is manufacturers' claims. We would be putting out manuals of performance and manuals of how to evaluate the actual inplace performance of systems which are currently being made for small systems.

Chairman **Ambro.** But does this use of $4.25 million by these 10 people come from or does it diminish the work that you so excellently do in control technology devices?

Dr. **Reznek.** No; there is no reduction being worked out.

Chairman **Ambro.** There is additional money?

Dr. **Reznek.** It is additional, in the drinking water program.

Chairman **Ambro.** Thank you.

Dr. **Reznek.** Thank you.

Dr. **Gage.** Next is Dr. Vilma Hunt, who will talk about health.

Dr. **Hunt.** EPA, as a regulatory agency, must determine the relationships between pollutant dosages and effects on human populations, and then weigh these effects against many nonscientific issues, such as the economic considerations, to ultimately arrive at a sensible and defensible regulatory stance.

To do this, it is essential that testing strategies in the health area produce the best possible estimates of a chemical's ability to produce human disease. Therefore, our research to improve testing methodology is critical and must be sharply focused in order to be effective. Three principal approaches are used to generate the scientific data required in establishing regulations. These are epidemiological research, long-term animal testing, and short-term tests with biological samples, micro-organisms, and plants, as well as animals.

First, I will focus on our short-term testing activities. This method is becoming more and more important as greater emphasis is placed on chronic effects, such as neurological disorders, which characteristically appear several years or decades after the chemical exposure has occurred. In the development of regulations, there must be definitive evidence that a chemical causes these latent effects. Such definitive evidence comes from long-term studies using live animals. As you are aware, these methods are not only expensive, but estimates of the world laboratory capacity for such long-term studies is only 500 compounds a year, and about 700 to 1,000 new chemicals are introduced into commerce annually.

For these reasons, we are continuing to develop and validate short-term rapid screening test systems to serve as predictors of human disease development in response to environmental chemical exposure.

In this way, the potential number of more expensive long-term studies will be reduced.

We are concerned with developing and applying methods to evaluate the response of all human organ systems to a chemical exposure. One such system, the neurological system, is the most critical to healthy, normal functioning, and yet it is highly sensitive to toxic and insult. Because of the crucial role of the nervous system, neurological effects are receiving greater emphasis in our research program. Effects in this system cause changes in the way we feel, see, hear, and move.

Study of the neurological system is also extremely important to the economist and to the ecologist. For example, organophosphate pesticides are economically useful for protecting food crops because of their direct effect on the nervous system of insects. We notice similar effects occur in exposed human beings; but, the extent to which behavioral problems and neurological deficits occur needs further study to determine what amounts of pesticides are safe to use.

Some of the agents which have been evaluated by our laboratories for neurological effects include lead, mercury, kepone, mirex, ozone, microwaves, and carbon monoxide.

This slide shows how the motor activity development in rats is evaluated. The procedures test how well young rats can move as a result of exposure to chemicals prenatally.

Mazes are also used to determine motor activity effects. The behavior of these rats is observed to determine whether the given chemical under study impairs their ability to discriminate between different pathways.

The technique shown here helps us to determine if the electrical activity of the brain is impaired by toxic substances. Brain electrical activity is critical to the control of vital processes in the body. Electrodes are attached under deep anesthesia. The animal experiences no discomfort when tested. The cable you see may be disconnected and reconnected many times for repeated recording sessions. The characteristic electrical brain waves are recorded, and they are analogous to the electroencephalographs or brain-scan readings, extensively used for human diagnosis.

I think you will agree that one of the most important aspects of our research concerns are children, and I am referring to the effects of chemical exposure on the human reproductive system.

Reproductive test methods used in the past were not highly sensitive to subtle changes which can result in adverse pregnancy outcome and subsequent development of the child. We are developing batteries of short-term tests in animals to determine the potential effects on the developing animal and the ability of mammals to reproduce and rear their young. A very promising short-term screening test identifies fetal defects. This screen is unique because it eliminates the need for lengthy evaluation of microscope slides for defects.

All that is required for the test is a count of the litter size and birth weight of the offspring, whose mothers were given the test substance before or during the pregnancy.

In teratology testing in general, pregnant females are exposed to compounds during formation of embryonic organs. Some animals are sacrificed before term and fetuses are examined. Others are allowed to give birth and the functional development of their offspring is monitored.

The success of mating is measured as well as offspring survivalship and growth. Now that we realize the sensitivity of the male reproductive system to toxic substances, we are developing a reproductive screen for sperm motility, sperm number, and fertility.

The next slide shows the types of defects that can occur with prenatal exposure to various substances. The fetus on the left is normal, but the other three have various abnormalities. The center two have shorter limbs and the fetus on the far right never developed the lower part of the body.

This young rat has a paralyzed back leg. This type of defect can result from prenatal exposure to various embryo toxic substances.

Chairman AMBRO. Excuse me.

Dr. HUNT. Yes.

Chairman AMBRO. This is all fascinating, but I think the thrust of these hearings is to relate these figures to programs, and at one point to get to some of the questions here.

I think we said that you should confine your presentation in total to 30 minutes. We have been an hour now. While I am really fascinated by the work you do, I think you have to get closer to the nub of the reason for these hearings. If I can be a bit authoritarian, please cut it down and relate more succinctly to the thrust of the hearings. While I hate to do this, and these things never do provide us with enough time to get to it, I just have to say that. So if you can in some way make it a little more targeted and a little more succinct, I would appreciate it.

Dr. GAGE. We appreciate your comments, Mr. Chaiman, and Dr. Hunt, Dr. Riordan, and Dr. Hirsch will attempt to shorten their presentations and bring this to a head quickly.

Dr. HUNT. I had merely planned to go on to make some comments on the nonionizing radiation component that is going on in the Office of Health Research.

Chairman AMBRO. I would like to hear that, and I would like to hear what you are doing with respect to emissions from synfuel processes so that we can compare what you are doing with our jurisdiction over the budget in DOE. If you can deal with those two, I would appreciate it.

Dr. HUNT. The overall purpose of this research is to develop data on the potential health risks associated with exposure to nonionizing radiation. Typical sources come from radio, TV broadcast stations, microwave ovens, and things of that nature.

Among the many activities of this program, two stand out in particular this year. We are now doing studies to determine the long-term effects of low-level exposure to 970-MHz waves. This frequency was recently allocated by the Federal Communications Commission for communications such as two-way radio transmissions between vehicles. This frequency thus, is a potentially important source of human exposure. This slide shows the exposure system used.

We are going to be conducting an epidemiology study. This one is of particular interest because it examines the mortality and long-term health experience of MIT scientists who developed radar systems during World War II, and identification of this population offers a unique opportunity to examine the survivorship of persons with one of the earliest experiences of radar exposure. This picture shows the individual back in those years, in the 1940's, working on the magnetron that was used for the development of radar.

I would like to emphasize that these new thrusts in the areas that I have just mentioned have been in part made possible by the fiscal year 1980 public health initiative and add significantly to the tools required to provide an integrated environmental approach.

Some of that work, of course, is also directed to the short-term bioassays, which I mentioned earlier. I do not plan to go into detail, as there have been many presentations on that work; but, indeed, in terms of the synfuel development, we could not proceed at all with the research that is needed in that area if we had not developed a short-term test. This allows us to evaluate in a rather shorter term the technological changes that we expect to see both in terms of control and of effluents from synfuels. If the technology is changed, you can test with a short-term test, and see if that change improved the quality of the effluents in health terms. If it hasn't changed it (the quality), let's try again. These short-term tests allow for far more rapid evaluation of engineering changes to minimize deleterious effects of the effluents than would be possible with only long-term animal tests which take up to 2 or 3 years.

Chairman AMBRO. Thank you.

Dr. GAGE. Dr. Riordan?

Dr. RIORDAN. Maybe the best thing for me to do is to scrap the formal presentation and just highlight some of the areas of the fiscal year 1981 budget.

I am representing the Office of Monitoring and Technical Support. The primary purpose of that office within the Office of Research and Development is the provision of methods to measure things in all of the environmental media—the air, water, soils, and hazardous wastes.

In doing that, we engage in three primary activities. One is the development of monitoring systems. By that, I mean, methods development, as well as the deployment of instruments out in the field.

The second activity we engage in is operational support activities for assuring data quality. We provide quality control samples for people to check out and calibrate their instruments and, also, to provide laboratories with performance samples having unknown concentrations. The last thing is we carry out specialized field monitoring activities to deal with particular problems.

One of the major highlights of the fiscal year 1981 program is the establishment of a mandatory quality assurance program.

As Dr. Gage mentioned in his comments, the Administrator of EPA has committed himself to a program of providing assurance in the quality of our environmental measurement and monitoring data that is collected by the Agency.

This is no simple commitment. We are talking about a significant demand on Agency resources where you could increase the cost of data collection and data storage in the Agency by as much as 10 to 15 percent, depending upon the current activities in the program offices.

In the air area, the budget also contains a significant amount of resources to deploy the next 120 monitors in the IPN network—the inhalable particle network—to measure fine particles in the atmosphere in support of the regulatory part of the Agency.

At the present time, there is a controversy about the total TSP or total suspended particles standard. There is a concern that one TSP standard may not capture adequately or precisely enough the potential health effects of suspended particles in the air, since effects are associated with fine particles. We are deploying by fiscal year 1981 a total of 300 stations to get a correlation between the total suspended particles in the ambient air and the inhalable particles. We are defining inhalable particles as those having an aerodynamic diameter of less than 15 microns. We are trying to collect the data base that will be used by the Agency in revising the TSP standard, if necessary.

Another major activity in the fiscal year 1981 budget is the hazardous monitoring research program. It is an area where we have an increase in the fiscal year 1981 budget. The primary purpose of this program is to grapple with the very difficult problem of how to sample hazardous wastes, how do you transport them, how do you prepare them for analysis, and then how do you analyze them?

We are also engaged in remote sensor monitoring for the discovery of sites and, also, for the evaluation of these sites.

This is a picture of a hazardous waste site. It shows a site which was recently overflown by our people. We are now presently analyzing the situation and passing that data on to the region for possible enforcement action.

I've alluded to the mandatory quality assurance program earlier—this next slide simply shows someone in a laboratory engaged in the gas chromatograph—mass spectrometry, examination of some chemicals.

Field monitoring support, I also mentioned earlier, but I'd also like to just highlight our participation in the Three Mile Island episode.

Almost immediately after the Three Mile Island accident occurred we were called in to carry out ambient monitoring relative to radioactive releases in the area. We set up 18 air monitoring stations which are shown on this particular map, as well as some selected drinking water and surface water locations for sampling water.

We engaged in that activity jointly with other Federal agencies. They met on a daily basis for the assessment of the situation as it developed. We have recently submitted a report on the Three Mile Island episode. We are also committed to a long-term monitoring presence up in the area. We have people up there now who have recently been taking measurements and, based upon my recent communications, we are getting results which correlate well with the NRC.

We can expect in the future controlled releases to the air and, ultimately, treatment of contaminated water, and we will be monitoring that activity as well.

That concludes my presentation.

Dr. GAGE. Dr. Hirsch?

Dr. HIRSCH. Mr. Chairman, I'm going to relate my presentation as quickly as I can on the fiscal year 1981 budget.

Basically, the function of this office is to understand the behavior of contaminants once they get out into the environment and to understand what they do to ecosystems and how they move through the environment to reach man.

As Dr. Gage has emphasized, much of our focus here is moving heavily toward the study of toxic wastes. Our fiscal year 1981 budget does include substantial increases in this area.

I just want very quickly to show you a few examples of the kinds of things we are doing here.

You mentioned a concern for groundwater. In this slide we are trying at our Ada, Oklahoma laboratory to develop techniques for understanding what happens to toxic wastes as they move into the ground, whether or not they reach the aquifer, and whether or not they contaminate it. These are simply soil columns by which you can track what's happening to a given chemical as it moves down through the ground toward the groundwater.

We are doing considerable work on the effects of toxic wastes on aquatic organisms. What we want to show in this slide is simply the fact that we are working to understand, the chronic effects of toxic wastes. It used to take about a year to go through a life cycle of a fish, that is, from egg through the growth of the fish, to obtain results as to the low-level chronic effects; now we find that, within a matter of weeks we can get the same results by working on these embryos here. This information is now being developed for our water quality criteria documents which are mandated under a court order, and we expect this work to continue on into fiscal year 1981.

A key question in this whole toxic area is identifying what is contained in these very complex mixtures. Here we are working at our Athens lab to develop something called a master analytical scheme, which will greatly increase our effectiveness and reduce the costs of identifying the very complex organic wastes.

Let me move on to say that, although a lot of the thrust that you see in this budget is toward toxic waste, we are working in a variety of other areas, as well. I am just going to touch on a few of them.

Acid rain—we are just in the process of completing a short-term assessment of what is happening in this area. This slide shows differences over the last 20 years in acidic areas in the Eastern United States. The pattern of red is the pattern of acid rainfall, and you can see how it has increased.

A part of the problem we are finding is that we have to be able to track air masses over very long distances. We used to be concerned about modeling in the vicinity of a smokestack. We are now putting more and more of our emphasis into these longer range regional models. That work will also be a focal point of a lot of our work in the next fiscal year.

The Great Lakes, I know, is an area of concern to this committee. In that area, there is going to be, as you know, a substantial decrease in our fiscal year 1981 budget. This is simply a research vessel—a sample.

Integrated pest management—while you see a decrease in our budget, actually, there is going to be an increase in our total level of activity because we've reached agreement with the Department of Agriculture for joint cost-sharing in this area.

This is simply a slide of insect traps using pheromones which are sex-attracting devices that are altered in a way to try to control insect populations.

Ocean waste disposal—in this area we are going to be working very actively through this year and the next to assist the operating parts of our Agency to determine whether or not communities need a lesser degree of waste treatment that is secondary treatment for discharging into the oceans.

In this slide we are working with oysters as a monitoring technique. It is very critical to know whether or not these wastes are doing damage as they enter the environment. We are measuring the growth of oysters as a way of telling whether or not damage is occurring at lesser than secondary treatment.

That is a very very quick runthrough, Mr. Chairman. I think I will cut it off right there.

Chairman AMBRO. On the last point, why do you use oysters?

Dr. HIRSCH. We are experimenting with oysters because they are an organism that will grow in a variety of marine environments; we can measure the growth; and also they are a commercially important organism.

Chairman AMBRO. That conflicts with testimony we heard from the Corps of Engineers and its researchers, which said that oysters were selective, and they used mussels which are not.

Dr. HIRSCH. We use mussels, as well, sir. We have something called mussel watch, in which we use mussels for determining the concentration of contaminants in the organism's tissues.

Chairman AMBRO. But you still use oysters as well?

Dr. HIRSCH. Here we are experimenting with oysters, as well.

Chairman AMBRO. Let me start by saying that it is my understanding of the perception around here that we have reached a point where there is a drastic shift in the attitudes of the Members of this legislative branch in supporting environmental initiatives. That is not to say that those of us who sit on these specific committees do not support very vigorously the work that the Office of Research and Development must do to support regulation writers who come under increasing attack, but the criticisms, even in terms of this presentation, I think, are monumental, but should not be used as a backdrop for your feeling that we don't support the kinds of things we think you ought to do. The paradox in this situation, it seems to me, is that, as we move increasingly to find energy alternatives, such as the shift from oil to coal, we have to be even more protective of public health by virtue of the kinds of environmental degradations caused by that shift.

Just to start it off, in terms of your own testimony, when you talk about the continued integration of research and development planning into the mainstreams of the Agency's regulatory and enforcement activities, it seems to me that it was this committee and subcommittee that tried to tilt the Agency in the direction of doing precisely that even more vigorously. Now you keep talking about short-term or short-fuse congressional mandates, but let me ask you this question: Aren't there regulatory deadlines that must be met?

Dr. GAGE. Absolutely.

Chairman AMBRO. Five-year programs, long-range programs, are all fine, if indeed they are timely. But do the kinds of things that you do anticipate those regulatory deadlines by your planning of research programs to meet those deadlines? We have regulations promulgated in the absence of fundamental data; and, when those regulations are questioned, the Agency responds that the Office of Research and Development is looking into the consequences of those regulations. Now that leads to a lack of credibility on the part of those who are deeply involved with and share environmental concerns. Do you follow my point?

Dr. GAGE. I believe so. I don't believe your point is completely clear in the situation that has developed, with the Congress passing a large number of authorizations with many detailed stipulations on those regulations, including the short deadlines.

I think the situation will be getting better, Mr. Chairman. With the amendments to the Clean Air Act of 1977 regularizing the schedule to review the criteria on which the major air quality standards of the country are based, we can move into a period when we have some idea of what the horizon is going to show to us, as those standards will be reviewed every 5 years. That has already made a fundamental difference in terms of our ability to be able to plan, say, the use of our inhalation facility—that is, we can plan to do ozone and nitrogen oxide experiments now, and get them reviewed so that they can be phased to the next review of the criteria documents 3 or 4 years hence.

We have clearly been faced, as I know you have recognized, with such short deadlines on the preparation of regulations that there was no time to undertake any new research. I am speaking of "we" as the Agency.

So in many cases, we are looking at these problems retrospectively because there was no other way in which we could undertake that work—the combination of an urgently required deadline by the Congress and promulgating the regulations and the realities of doing research in the real world.

Chairman AMBRO. I don't accept that. For example, let's talk about the concern of our colleagues from Illinois—the barium standard for drinking water. The Clean Water Act was passed, as I recall, around 1972. We knew the kinds of concerns that we developed from implementing that act and that which the EPA should have undertaken with respect to a variety of contaminants. Why now, as a reaction to some Member of Congress, do you decide to go into this? We knew, for example, that there were toxic effects from the leaching of organic phosphates or other kinds of metals into groundwater and surface water. We knew that, when you move in the direction of burning increased amounts of coal that you'd have the kinds of mixtures that would cause acid rain, but what are we doing here? Are we reinventing the wheel? Are we saying that now we are going to look into it? Why haven't we been looking into it before?

You know I have talked to EPA people for 5 years around here about these same things, and we keep hearing the same things that we have this kind of programmatic shift, and this kind of programmatic change, and this kind of time frame, and all kinds of other things, but they don't seem to relate to the real world. I am most disappointed in what is going on here because I can't see the relationship which is so important between the work you do and the kinds of safeguards that we have to have from the regulation writers. Maybe you can comment on that.

Dr. GAGE. I would like to, Mr. Chairman.

There is no reason for any of us sitting at this table to apologize for the situation in the earlier days of the Agency. They where hectic, they were frantic, there were short deadlines, and things got started. I think we are doing a lot better now.

Dr. Reznek gave you a perfect example of the way we are fundamentally affecting the direction of regulations. There is the example about the new source performance standards for large coal-fired powerplants.

We probably have saved this country billions of dollars because of our involvement in that particular regulation because it was the Office of Research and Development that came up with the dry scrubber operation for 70 percent control on western low-sulfur coals. We got that, worked into the regulation so that it could become a fundamental part of our approach for dealing in a cost-effective way with sulfur-oxide pollution from new coal-fired powerplants.

That is a very substantial involvement. We had a fundamental impact on that regulation. We are trying to do that in a number of other cases.

Steve also has responsibility right now for doing the technical details on the industrial boiler new source performance standards, probably the next largest impact relating to sulfur and nitrogen oxide pollution from increased coal burning. We are having that impact.

We have been working for 5 years on the energy program. Many results have come out of that which have fundamentally influenced the way in which the Agency has dealt with the criteria pollutants from coal-fired powerplants. We've had our impact there in that period of time; and we will have increasing impact now with the recent control documents that we are preparing for the synthetic fuel plants. We have already gone through a trial run on one of those. We started, in fact, 3 years ago. We are doing a pollution control document on the geothermal industry.

Chairman Ambro. Wait a minute.

Dr. Gage. And that is influencing the investment cost in the geothermal industry right now.

Chairman Ambro. Let me stop you. I will just run through this point, and then I will defer to my colleagues, and then get back to a variety of staff questions with respect to the budget.

I think you touch on something that forces me to comment. For example, I think Dr. Reznek's component does excellent work, according to what staff and other people have talked to me about it. But we knew about the problems of sulfur and the attempt, maybe in the private sector by themselves, to develop flue-gas desulfurization systems 10 years ago and the byproducts of flue-gas desulfurization. Now we are told that we have three pilot plants of 10 megawatts when I doubt very much that this conversion order, which will affect practically every plant on the east coast and will be promulgated the day after the New Hampshire primary, can really apply the kind of technology that you are looking at for the removal of sulfur in any efficacious way and that deals with the horrendous disposal problem. Where do those things come together? Ten years ago we knew about the mediocre technology, the Rube Goldberg devices, and other various technologies in trying to do this. I don't see that we are much further along the line.

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Dr. Gage. I will have to take very strong exception with you on that point, Mr. Chairman.

Chairman Ambro. Why?

Dr. Gage. At that very pilot plant which Dr. Reznek showed you, we pioneered the fixation processes for sludge coming from limestone boilers. That is a project that we started over 7 years ago. It was carried through. We have manuals out to help individual powerplants and consulting engineers that work for individual powerplants fix sludge in an environmentally acceptable way for land disposal.

Right on your east coast, we have demonstrated flue-gas desulfurization techniques which would result in commercial grade sulfuric acid. That was at the Boston Edison plant at Mystic—a project which has already been concluded.

So we have been there and we've been involved. I can't say this categorically across the board; but I don't think we need to take a second seat to anyone in anticipating problems and in dealing with those problems in a straightforward and as timely way as possible.

Chairman Ambro. I don't want you to take a second seat. I want you to take a first seat.

Dr. Gage. We do.

Chairman Ambro. I do not think the private sector has either the resources or the capabilities to develop the kinds of technology that must be developed in order to solve both the economic and the environmental problem that we absolutely will confront in this decade. In 1990 there will be a confluent, so we are told, of all kinds of energy alternatives. The problem is the next 10 years, and the severe impact, both environmentally and economically, of the kinds of things we are moving to. I want to know if there is a real relationship between research and development done by EPA, DOE, the Corps of Engineers, or whoever might have their finger in this R. & D. pie.

Steve, do you want to comment on this just for a second, if you don't mind.

Dr. Reznek. Yes sir. As you know, we have gone through rather a lengthy process to straighten out mechanisms and cooperation between the Department of Energy and ourselves in this area. I feel that is working very well—the transition from a lead in the Environmental Protection Agency to a lead in the Department of Energy. At least for the hardware project it has not been a particularly easy one or a smooth one. It has been a short-term penalty.

We get together frequently—at three major sessions a year. We sit down and go over what we are going to do and what they are going to do, to suggest better ways of getting it done and to select the projects that are to be done.

I think there is a commitment—a sense of urgency, a sense of feeling—that we have to bring down the cost of air pollution control.

In our own State, we have gotten together with the New York State ERDA and have a demonstration program now underway to turn scrubber sludge into bricks and to build an artificial reef off Long Island with those bricks. It is going very well; these bricks are holding up and are not falling apart.

Chairman Ambro. But is that sense of urgency translated in this budget, or is this budget an amalgam of the notions of OMB, the political process in the White House, and a touching of one base or another to kind of ameliorate the attitudes that you get from this subcommittee? Do you think this is a sense of urgency budget?

Dr. GAGE. I'll let each one of my colleagues speak to this specifically; but, disregarding the acute areas where we did not find our priorities reflected well by the Office of Management and Budget, I would say it is generally a well-balanced budget.

Chairman AMBRO. You are up to $368 million over $341 million in 1980; right?

Dr. GAGE. That's right.

Chairman AMBRO. That is not even a reflection of the inflation rate.

Dr. GAGE. That's right; but, on the basis of the overall budget pressure throughout the Government, I think the Office of Management and Budget treated us quite squarely this year.

Chairman AMBRO. I don't have your submissions to the OMB, so I can't comment.

All right. I wanted to get those kinds of general frustrations out on the floor. Now I will turn to my kinder colleagues.

Mr. WATKINS. Without question, I share the chairman's frustrations. I apologize to the chairman, to Mr. Walker, to the staff, and to the audience for the remarks I am about to make.

It has been 1 week, 45 minutes, 30 seconds or so ago that I placed a call to you, Dr. Gage. They said you were on the phone. That must have been a long phone call because I haven't gotten a call back.

I wanted to talk about some things—personal things—that had me frustrated, disappointed, disturbed, and distressed, because I am wondering in which direction the Agency's R. & D. program is going. I wonder, like the chairman, whether we know the direction. Maybe it is OMB; maybe it's the Presidential primaries; maybe it's the self-interests of the EPA that are involved here. I know there are a lot of other interests that are not being taken care of.

I wanted to talk to you about these interests and concerns, as I mentioned to Mr. Hall and Ms. Harrison and others back some time ago, and I have not been able to get the answers to my questions out of your office, Dr. Gage. As you well know, I've been trying to work very professionally, not politically. I tried to talk to Dr. Gage and others, but it seems like I can't seem to find the courtesies I expect.

I wonder if we do know the direction we are going. I would like to know what is the projection over the next 3 to 5 years of which way we are going in groundwater research. That was supposed to have been a major thrust of EPA. I see that it is not a major thrust in reality.

We talk about a 5-year plan. I would like to ask and request, if there is no objection from this committee, a projection of where Dr. Gage proposes to go with the Agency's research program if we have a 1-percent increase in our budget or if we get a 5-percent increase in budget, or somewhere in that neighborhood, so we can know what that thrust is going to be from their office. It seems like a lot of interests that I know are shared by many are getting shoved back.

I will be honest with you—and I think the chairman might be looking at it also—I want to look at that budget projection, and I may want to offer some amendments. I don't know if we need that. But it seems like money can be found for certain things but not found for others.

I would like to ask you a couple of questions. In fiscal year 1980, for the renewable resources program, the funded level is about $3 million and 24 positions. This is split between EPA headquarters at Athens and Kerr laboratories, the latter of which has about nine full-time and about two part-time positions. In fiscal year 1981, EPA asked OMB for $2.3 million and 18 positions but they cut the entire program to almost zero. The budget submitted by OMB was about $300,000—about 11 percent of EPA's request and 10 positions. Further, it is my understanding that those 10 positions have not been allocated yet among EPA headquarters at Kerr and Athens.

Is this still the case that they have not been allocated—that no decision has been made? It appears to me that your intention is to pressure this subcommittee into restoring full funding for programs in a lot of areas.

As I mentioned to you, I am willing to take heat as long as I know your position and those people's position is to try to build a groundwater program. I can't say that we are going that way. Can you answer that question?

Dr. **Gage.** I would be happy to, Mr. Watkins.

The resources we had in our request to the Office of Management and Budget this past budget season would have been adequate. You mentioned one number—the 18 positions and the $2.3 million in renewable resources, plus the 46 additional positions and some $12 million in hazardous waste. This would probably have meant at least a net increase of some four to five positions over the current base at the Ada laboratory.

What we were faced with when we went to the Office of Management and Budget was first, the zeroing out of the renewable resource program. That program, of course, is going to be one of the areas from which we are going to reprogram to give the Ada laboratory more groundwater orientation. However, something happened on the way to the forum.

The Administrator fought long and hard for full restoration of the renewable resource program and, frankly, got only 10 positions and enough money to cover their salaries. That is a quarrel that is not with us. It is with the Office of Management and Budget.

We are trying to work out the best arrangement possible using resources that we have available or see becoming available during fiscal year 1982.

Mr. **Watkins.** Dr. Gage, are the 10 going to headquarters or where are they going?

Dr. **Gage.** The 10 will be distributed between the Athens and the Ada laboratories.

Mr. **Watkins.** No decision has been made?

Dr. **Gage.** No; it is contingent, in part, on the decision we make on the distribution of the positions for hazardous wastes.

Mr. **Watkins.** Let me say this, Mr. Chairman. I think one of the things we will do is look at some of these requests before they go down to OMB next time and see where we are before we get down there.

Chairman **Ambro.** Well, one of us will get elected President. [Laughter.]

Dr. **Gage.** I think the President sees the budget request long after OMB sees it. [Laughter.]

Mr. **Watkins**. Well, I am not kidding. I want to know what you all are willing to fight for; and if it's 1 percent, or if it's 5 percent, or if it's 10 percent, I want to know. I don't want to be giving people my word on something, and then finding myself misinformed, misled, and unheard. I have to go back to the voters. I don't think anyone is sensitive about that sometime.

Dr. **Gage**. I am fairly sensitive because I have to come up here and sit in front of you, Mr. Watkins. We made a good-faith request to OMB, and we went in and fought for it right down to the final line.

Dr. **Watkins**. In response to a subcommittee question, Mr. Costle said he hoped that the Agriculture Department might fill part of the void created by EPA's termination of the renewable resources program. Is it true that virtually all of the research for renewable resources that is being currently conducted by USDA is funded by and through the EPA?

Dr. **Gage**. Much of the research activities have been done jointly with the Department of Agriculture, but I would like to turn to Dr. Hirsch and get him to help me out on this.

Dr. **Hirsch**. The difference, Congressman Watkins, is that the Department of Agriculture has done a lot of work on developing the practices on the land itself through agricultural productions and so on. EPA's money has gone more into what impact those practices have on water quality.

Since we were cut by OMB, we have been in discussion with agricultural officials trying to persuade them to pick up the piece that we can't fund. Thus far, I can't say that we have had a very positive response, simply because it has not been their mandate to date.

Mr. **Watkins**. That is exactly right. It has not been their mandate and it is literally going to go down the drain. It will be terminated, kicked out, and washed away. The best you can say is that most of the USDA's renewable research will probably be terminated, if EPA terminates it, you know.

Dr. **Hirsch**. They will continue to push for the implementation of best management practices under the rules of the Clean Water Act, but what that won't do is indicate what impact it's having on the environment, whether or not we are getting benefits back equivalent to the costs and so on. That is the area of work that we were emphasizing. Unless we can persuade them to do it, I guess that simply won't get done.

Chairman **Ambro**. Can you yield just for a second?

Mr. **Watkins**. Yes; I yield back to the chairman just for a second.

Chairman **Ambro**. Mr. Watkins mentioned going back to the voters. Now I know we are constantly charged with thinking solely about the voters, but voters are people, too.

This press release on CEQ's report on the state of our environment came out today with great fanfare and hoopla, and it says something that we on this subcommittee could have written almost verbatim, and I have been saying to you, and I quote, "Although groundwater quality may be viewed as good from a nationwide perspective, this is little comfort to those who must rely wholly on groundwater supply being graded." Then it goes on to list the horrors of everything that we have always known around here for years, that is, increasing groundwater contamination, landfills, sludge storage, highway deicing, mine tailings, industrial waste pits and a million more. The budget request for groundwater research is $2.52 million nationally. That is an actual decline in terms of real research production.

I think the question is simply why is there a decline in this most vital field when the White House issues the notion today in this press release that there is increased evidence of groundwater contamination. "No kidding," says our people who also vote. "Why don't you lumps in Congress do something about it?"

How does one explain that which we lumps in Congress know about and have been trying to do something about and the kind of response we get, year after year, Dr. Gage, from your office, with respect to moneys for this kind of effort? How do we do that?

Dr. **Gage**. You are beating on us, Mr. Chairman.

Chairman **Ambro**. Well, I don't want to do that. I hate to tie in an executive branch agency with another executive branch agency and a White House press release and not, at least, raise the question in some meaningful way so that we know what we say about the differences between Congress perception of the problem years ago and what the White House has now found is a problem. Where do we go from here?

Dr. **Gage**. I think we are making a lot of progress. I think we have moved ahead very well. We moved out fairly aggressively 2 years ago in the groundwater area in the face of some considerable opposition in the Agency.

I am pleased to say that we are bringing other parts of the Agency around and we have a very large effort underway in the Agency now to develop an overall groundwater strategy for EPA, not just for research and development.

We couldn't swim up that stream alone. We are not having to. In fact, Mr. Watkins, we are developing a multiyear plan for groundwater and it is part of the drinking water research committee. The chairman of that particular working group is Jack Keeley of the Ada laboratory, and we would be happy to work in different levels of funding projections, if you would like to have us do that.

I think that strategy is probably going to be very important in getting the real impetus toward increases in the fiscal year 1982 budget.

All I can say with respect to this past year is that the major pressure from many, many sources outside and from many, many sources inside the Agency was to put all of our net gains that we possibly could into the hazardous waste area because we were so woefully short of what should be done there.

It is a 1-year decision. It is a 1-year response to the accumulation of literally years and years of past decisions which held the solid waste program down, which held our effort to 20 positions in solid waste control technology and kept that work focused on municipal solid waste without any work in the hazardous area because the party line was that that work was going to get done by industry. Now we are faced with a situation where we nearly have a crisis on our hands. We move as quickly as we can to deal with it, and it pushes other things out of the way.

Unfortunately, that is the kind of pendular work situation we live in in the budget world as well as in the political world. All we can do is bring you the best budget we can put together year after year.

I frankly think that groundwater is probably on the upturn for the next year. Hopefully, I or my successor, can come here a year from now and point to a very solid program increase in the groundwater area, by 10 percent.

Mr. WATKINS. I agree with the chairman. We have a situation where we get tremendous rhetoric. Do you think that's probably all it is is rhetoric? You know, from the standpoint where we yank all these people and shift them down to the gulf or shift them to other places to handle the hazardous waste situation, instead of saying—all right, we have the thrust here; we are going to have to have some other people. This time the Agency is getting 200 new people, but are losing 20 out of research and, as the chairman said, it is hard to go out here and defend the regulations when there is no research done, based on some of the standards that come out.

Basically, it is the environmentalists that are insisting on the Congress to put a short fuse. There are people that work with you all daily—with Mr. Costle daily—and you can tell them to get off your backs and give us some breathing room—let the Congress have some breathing room. Those are the people who are causing the short fuse to be placed in the legislation. I think it behooves some people to tell them to get off your back.

On groundwater, we know it is going to be a major problem in the decade. The Speaker of the House said it was going to be a major problem of the decade. We all talk about it being a major problem in the decade. I hope that Mr. Costle and others, and you, will indicate what the thrust of this has got to be or we are going to be in a terrible situation in Long Island and in a number of other places concerning groundwater in this country. I think it is very important as we try to look towards this. I would like to make sure that we have that concerning groundwater. It is important.

Let me ask another question. You talk about competitive bids and competitive grants. Evidently there is a thrust bringing all research grants back into headquarters that have been allocated out there in different areas, so that they can be allocated from Washington, instead from the areas of expertise. I understand that East Central University has about a $50,000 a year grant with the Kerr lab to operate the technical information. That has been in operation for several years. There is a lot of expertise in that area, mainly, the animal waste program. They have aways been telling me that there has been a good job going on there. With this new grants program, they are taking everything back in. Basically, they would be able to continue these programs over the period of the contract. I think, maybe with the exception of the one there at East Central. Why the difference in policy? What is the situation there?

Dr. GAGE. Let me address the general question, and I will ask Allan to address the specific one with respect to that particular grant.

In 1977, Congress passed the Research Grant and Cooperative Agreement Act, which gave us new mechanisms for dealing particularly with universities and nonprofit institutes; namely, the cooperative agreements EPA and most other Federal agencies had not used the cooperative agreement I think only the Department of Agriculture exercised that to an extent.

This new act very clearly delineated the roles of the grants and the cooperative agreements. The cooperative agreements—as we are sorting it out within the Environmental Protection Agency—are the full responsibility of the laboratories, to extend their capability to deliver the products that they have been asked to deliver.

To reflect on the particular case you mentioned, the technical information activity conducted at the university in Ada would have been a very likely candidate for a cooperative agreement between the Ada laboratory and the professor involved.

I'm impinging on Allan's answer here, but that area happened to have been in renewable resources, and that gets to the next matter here.

What we are doing is trying to get more new scientists involved in environmental research—as this subcommittee, in particular, has urged us to do a number of times—and to get them thinking on new problems. We are using the competitive grant system, with these wide solicitations that I mentioned earlier in my opening statement.

If something has been taken away from the laboratory—if you want to put it that way, but which is not quite the case—they have been given, if you will, the cooperative agreement to fully carry out all the responsibilities that they in the laboratory can use.

Mr. Watkins. Dr. Gage, you told me specifically you would work with me in trying to improve the East Central situation, and you turn right around and it's chopped right off without even discussing it.

Dr. Gage. Allan, can you speak to the renewable resource question again?

Dr. Hirsch. Yes. The grant in question is one to provide updated information on animal waste. When our program was cut from $2.8 million to $300,000, we had to go through the painful process of figuring out how to wrap that up this year.

Our decision was to try to get as many good final end products, as possible, out of all the ongoing work that we had done in order to have something to show for 10 years of effort and not just drop it in midstream.

Mr. Watkins. Well, you know, other contracts you continued. That one you whacked.

Dr. Hirsch. We did not continue them all. We continued those that were leading toward completion of some kind of final report. This contract is an ongoing one, and a very good one. It was going on year after year after year. Our judgment was that we were going to have to close down these ongoing things because there was no way of funding them.

Mr. Watkins. Does your word mean anything? Why wasn't I told?

Dr. Gage. I am completely committed to continuing to work with you.

Mr. Watkins. I have been trying to get a phone call back for a week.

Dr. Gage. The point is——

Mr. Watkins. What did you say for the record?

Dr. Gage. I put a call back in and I was told that you had left for Oklahoma. I am sorry we missed.

Mr. Watkins. Let me tell you. I usually can be reached Sundays, Mondays, Saturday nights or anytime else—you know, because I go home and take heat—and you were going to help me work these things out, and that is what I would like to do.

Dr. Gage. I apologize for the lack of perseverance——

Chairman Ambro. I wonder if we could cool it off for a minute, and ask that you defer. We will go around again, but Mr. Walker has to leave at 4:30. I am sorry to put a time constraint on you like this.

Mr. Watkins. I apologize. Don't be sorry.

Mr. Walker. Thank you, Mr. Chairman.

I was interested in the presentation on the monitoring system around Three Mile Island. We have quite an impressive diagram of monitoring points that you have there. Are those all 24-hour monitoring systems, or does that consist of a few dosimeters that are checked periodically? What is the nature of that monitoring capacity?

Dr. Riordan. I can't answer that right at the moment. I believe it is not an intensive sampling program. I don't know that the sampling——

Dr. Gage. Excuse me. Let me break in here. I happen to have been put in charge of that process by the Administrator immediately after the accident.

They are continuous monitors, which are collecting the radiogases, the radiokrypton, and now we are not worried about the radioxenon because most of it decayed.

In addition, we are taking measurements on particulate samples in case any of the gases or any other materials have beeen released into the environment. These are continuous and they are read out periodically in the data accumulated.

Mr. Walker. Was it sophisticated enough to pick up the releases of gas this past week?

Dr. Gage. Yes; it was.

Mr. Walker. Were there offsite releases that were picked up by that monitoring equipment last week?

Dr. Gage. Yes; very small increases were shown above the background levels for the radiokrypton.

Mr. Walker. That, of course, differs with Med. Ed.'s contention that none of the radioactive krypton got off site?

Dr. Gage. It absolutely conflicts with that.

Mr. Walker. Could you send to me for the record the material on that as to what those readings were offsite, please?

Dr. Gage. Yes.

Question. Would you provide your readings for the record?

Answer. For the 48 hour period beginning at 1:35 p.m. on February 11, our readings for Krypton 85 were 66 pico curies per cubic meter. Normal background levels are always less than 40 pico curies per cubic meter. Our readings were taken at the Three Mile Island observation station.

Mr. Walker. The only other question I have with regard to that is would there be any money in the budget that would permit a tie-in between that system to give notification to State and local governments, immediate kinds of notification about releases of radioactive materials from those plants?

Dr. Gage. From the early days following the Three Mile Island accident, we worked out a notification process in which we notify the Nuclear Regulatory Commission people on site, the State of Pennsylvania people on site, and the Nuclear Regulatory Commission Crisis Center here in Washington. The State of Pennsylvania gets the information as soon as it is accumulated and analyzed.

Mr. **Walker.** In this particular case, the other day, evidently the Governor of the State was not notified for some time after the gas actually had been released. The local officials were also left in the dark, and there is a considerable question arising in that area about the ability of monitoring systems to give local officials the capacity for responding.

I am just wondering whether or not the monitoring system could not be revised in some way to permit them to have their own independent data almost instantaneously?

Dr. **Gage.** I can give you assurance that any release of any significance would be picked up immediately because we have what are called rate meters on the instruments. That information can be relayed.

However, the releases which we did measure most of the time following the Three Mile Island accident were so low, so close to background levels, that we had to remove the cartridges on which we trapped the radiogases and take those back to our Las Vegas laboratory and analyze them in a very low background counting chamber.

Unfortunately, we do not have capability here on the east coast to do that kind of low-level background, but that is not a real concern.

Mr. **Walker.** I guess what I am talking about really is that I would like you to consider exploring some way of tying in State and local officials to that monitoring capacity because, as it is right now, they are under some pressure to put in their own independent monitors which, in my opinion, would be a disaster—to have local governments out monitoring as well and doing their own interpretations of their own data.

I think it would be far better to utilize the monitoring systems that are in place and have everybody share in the information. Their prime concern is not gathering their own information, but simply having access to information as it becomes available. I would like to encourage that kind of action.

If I could, I would like to deal a little bit about the research that has been going on in the diesel area and find out where the research dollars that are in this present budget tie into that. If I understand correctly, up until now, about $17 million has been spent on research in diesel technology. Is that about right?

Dr. **Gage.** Yes.

Mr. **Walker.** And that this budget has about $7 million in it for diesel work?

Dr. **Gage.** Yes.

Mr. **Walker.** One of the indications that I've had, in some research I have been doing in the area, is that industry feels that it is impossible for them to meet the hydrocarbon reduction required in the EPA standard. What they say is that it is not technically feasible to do so. Do you have any research based on your $17 million work that indicates that it is technically feasible for them to meet those hydrocarbon reduction standards?

Dr. **Gage.** Dr. Reznek, do you want to comment on that?

Dr. Reznek. Yes. Mr. Walker, in the Office of Research and Development, we have not had a technology R. & D. program in mobile sources at least since 1974.

The EPA work that is being done on the performance of diesels is by the Office of Mobile Sources under the Office of Air Noise, and Radiation programs.

So within ORD we have used none of that $17 million and the present $7 million on the performance of controlled systems.

Mr. Walker. So the answer to my question is, No, you do not have any in-house research which indicates that it would be technically feasible to meet those standards at this time?

Dr. Reznek. No; we don't in ORD.

Mr. Walker. There is also a significant question about NO_x standards. We understand that industry has found it impossible to duplicate the EPA test results. If this is the case and if there is a real question about the NO_x standard, what can we do about that?

Dr. Reznek. Sir, I don't want to leave the impression that there is no work going on or that we can't respond in writing to your questions. The work that is being done is being done within our mobile sources program. What I would like to do is volunteer to get the responses, both in the particulate and hydrocarbon and the NO_x back to you based on the work that is being performed in Ann Arbor, at the test facilities in the Office of Mobile Sources.

Mr. Walker. I would appreciate that. I want to see what the assurances are that some of these things are—particularly with regard to hydrocarbon, that you have something to show that it is technically feasible. What they are saying is they do not see how it can be done. I would hope that, if we are putting forth standards, you have something to show that it is technologically obtainable.

Then with regard to NO_x, also, if the test standards and if the testing procedure is under question, then it seems to me that NO_x standards themselves come under question. So I would like to have some material on that.

It has also been charged that the proposed idle standard for diesels is based upon gasoline engine experience rather than work with diesels. What is your response to that and what research did EPA do before proposing idle standards?

Dr. Reznek. I will have to respond the same to that. ORD did not participate in those tests. They were done by the Office of Mobile Sources, and we will be glad to collect the information and respond.

Mr. Walker. There have been a number of complaints that the diesel test cycle that the EPA has should be modified so that it can be run on currently installed dynamometers which would reduce lead time and testing costs. Are you working on a modified test cycle?

Dr. Reznek. Unfortunately, sir, I have to respond the same way. We can collect the information and send it back to you.

Mr. Walker. The EPA has come out with a suggestion that there would be a certain cost per engine for compliance with EPA regulations on diesels. I had indications from within the industry that their conservative estimate of the economic impact is some 415-percent higher than what EPA's cost per engine. How do you account for that kind of variance?

Dr. **Reznek.** Once again, unfortunately, ORD does not participate in this aspect of the mobile source program, and we will have to respond after consulting with the Office of Mobile Sources.

Mr. **Walker.** I would very much like to get the answers to those questions in writing.[1] This subcommittee may be looking in some detail at the diesel question before the end of this year, and I would hope that you will be in a position to respond with some completeness at that particular point on this because this comes back to the question the chairman has been raising about what we are basing these standards on.

What it sounds like to me is that EPA has been putting forth some diesel standards here. Evidently, there isn't much consultation with you about this as they are putting forth those standards. Maybe they are talking to your people in Ann Arbor, too. I would hope there would have been more input from the research component on something that is as vital to the automobile industry in meeting their mileage standards as diesel technology.

Dr. **Gage.** Unfortunately, we do not have the technical capacity to help very much on the automotive control technology questions, Mr. Walker.

Mr. **Walker.** But aren't you the one that the Administrator should be consulting with, with regard to what the research is that backs up the standards that they are developing?

Dr. **Gage.** With respect to technology standards for automobile sources, there has been a longstanding policy that Research and Development does not get involved in that; rather, to the extent that information has to be gathered or confirmatory tests run, this is done by the Office of Mobile Sources within the Agency. So when you have us back up to talk about the overall diesel program, my colleague Dave Hawkins, the Assistant Administrator for Air Programs, should be here, as well as his Deputy Assistant Administrator for Mobile Sources.

They are working on the health effects of diesel particulates and that is where our involvement, aside from work on chemical characterization of the emissions, would tie in.

Mr. **Walker.** And you are not included in the research on something as vital as this? I mean, you are totally divorced from the research process related to diesel and automobile engine technology?

Dr. **Gage.** Yes.

Mr. **Walker.** What is the reason for that?

Dr. **Gage.** It goes back to the early days of the 1970 Clean Air Act, where Congress made the determination that the only flexiblity the Administrator had in dealing with mobile source pollution problems was to make a determination as to whether or not the technology existed, and then to set a timetable for making technology come into light. However, that same framework has continued for the past decade and was reinforced by the 1978——

Mr. **Walker.** So what you are saying is that the Administrator is basically acting without research?

Dr. **Gage.** Requests are made for all technological data that is available from industry, the automotive industry and all the associated industries. That record is used as a basis on which to make a decision. That is spelled out very plainly in the Clean Air Act.

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[1] See app. 3.

Mr. WALKER. That is disturbing. I think that is one of the things we may have to take a look at as a part in the hearing process.

Finally, Mr. Chairman, I would just like to ask a question of one aspect of the Clean Air Act, on the National Commission on Air Quality. Can you tell me what the National Commission on Air Quality has really accomplished to this date, particularly, in the research area?

Dr. GAGE. They have launched a number of studies, Mr. Walker. As far as I have personal knowledge, they asked us to review their study plan and make any suggestions we might want to, as they did many people. I believe the studies are only a few months old at this particular point. They are holding a number of hearings and work sessions in connection with those studies, but that's all I know.

Mr. WALKER. Have they communicated any useful research results to you since they have been in existence?

Dr. GAGE. No; but understand that these studies have only recently gotten underway.

Mr. WALKER. If they would go out of business at some point in the near future, do you see any problem in EPA making suggestions to Congress for appropriate changes in the Clean Air Act, if they weren't around?

Dr. GAGE. Mr. Walker, I am much too concerned about my own demise, than to speculate on someone else's demise.

Mr. WALKER. Well, that is an issue that's out there. They evidently are up for reauthorization and don't appear to be reauthorized. Now you are telling me they have not submitted anything to you. Do you think you would have any problem if they were not around in suggesting changes to the Clean Air Act? You just talked about one here a minute ago that we might want to look at changing.

Dr. GAGE. From my review of the list of research topics that they have undertaken, there appears to be a number which can be of real interest to us. I would be happy to comment on this in detail.

Mr. WALKER. Rather than take time here, if you would submit to me for the record, I would like to, again, see which projects that they are undertaking that you think would be of value in revising the Clean Air Act.

One final question on the Clean Air Act. Do you know of any Federal facilities that have turned up in your research programs which are not in compliance with the provisions of the Clean Air Act?

Dr. GAGE. Yes; there were a number. About a year and a half ago, the Agency took a fairly vigorous enforcement program against those Federal agencies. I would be happy to provide from Office of Enforcement a status report on those actions.

Mr. WALKER. Are there any that still have not met compliance?

Dr. GAGE. I can't say that right at this point, but I suspect there are a few more.

Mr. WALKER. I would appreciate knowing the ones that were not in compliance, those that have come into compliance, and those that are still outside compliance, if you would.

COMPLIANCE BY FEDERAL FACILITIES

On October 13, 1978, the President issued Executive Order 12088, "Federal Compliance with Pollution Control Standards," directing the heads of Federal agencies to bring their facilities into compliance with the environmental laws as expeditiously as possible. The President, in issuing the order, reiterated his commitment to the goals of achieving and maintaining a clean environment. The executive branch is to provide leadership in that effort.

To insure that the Presidential mandate is carried out, the new order directs EPA to monitor the Federal facilities' compliance and includes a procedure for EPA, the Office of Management and Budget, and the Federal Agencies to use for resolving any disputes about noncompliance. Requests for exemptions from compliance, as authorized by the Clean Air Act, will be reviewed by the President and will be granted only in cases where he finds that national security or the paramount interest of the Nation is at stake.

During 1979 Federal facilities classified as major sources of air pollutants made continuous progress toward coming into compliance. As of December 14, 1979, there were 49 of the 294 major sources of air pollution and 89 of the 205 major sources of water pollution out of compliance. Of these 138 major source violations, 7 have installed the necessary equipment and are testing its operation for compliance, 51 are in the process of installing control equipment, and 80 have plans to correct their pollution problems. Of the facilities with plans, 20 will be in compliance by the end of 1981 with the remainder representing more recently identified problems. As far as I know, all Federal facilities are making a good faith effort to comply.

Thank you, Mr. Chairman.

Chairman Ambro. Thank you, Mr. Walker.

Just as a follow-on to Mr. Walker's interesting point, how much research is done outside ORD's control in EPA?

Dr. Gage. Some are more appropriately termed technical analyses or technical studies which are done in a number of the offices. It is fairly difficult to draw the line between such technical analyses and some of our research studies. I am sure there are transgressions, if you want to term it as such, across that gray area in between.

Chairman Ambro. Don't you raise the point that there is a significant area that we think is missing. For example, OMB shows EPA R. & D. funding at about $445 million. This exceeds your request by about $75 million. Now I think we will ask you to supply in writing answers to questions such as whether or not this reflects a different accounting procedure or definition of R. & D., how much research is being performed specifically by the regulatory offices and the nature of that research, and what this says about ORD and its responsiveness to the needs of the regulatory offices. So I will give you some time to look into that and provide this committee over which we have specific jurisdiction with answers to those kinds of questions. Thank you.

Mr. Blanchard?

Mr. Blanchard. Thank you, Mr. Chairman.

Mr. Watkins. Will the gentleman yield?

Mr. Blanchard. Yes.

Mr. Watkins. Thank you, Mr. Blanchard.

Dr. Gage, could I ask you to call me tomorrow. My office couldn't find any record of your returning my call the other afternoon. I would like to schedule a time that we might get together.

Mr. Blanchard, thank you very much.

Dr. Gage. Either here or in Ada, Mr. Watkins?

Mr. Watkins. Here would be fine. Return the call anyplace.

Mr. Blanchard. After all these questions, I feel I should ask you if you beat up on orphans and widows as well?

Dr. Gage. Just on little white rats. You probably saw the presentation

Mr. Blanchard. You are aware of my concerns about the Great Lakes and the water quality in the Grosse Ile facility. It is not in my district. It is in Congressman Dingle's district. When he gets mad, it's a vicious thing. He makes Ambro look like a velvet glove. So I hope you can reconcile that problem. I am just curious on all the funding issues. We've seen so many projects that were cut that involve items of near and dear priority to members of the committee. Of course, it is an old game here on the Hill that, when you are asked to cut the budget or OMB forces you to do so, you cut things that you know we will restore. This gives us something to do. This gives me a chance to issue press releases and be a hero back home. It keeps us busy so we don't snoop into how much of your budget we should have control over that other committees do, as Mr. Ambro wisely pointed out.

I just do not want to see us go through the same issues and fight the same old battles year after year. I am wondering about the cuts that concern people like Congressmen Fuqua. Watkins, and others. Are these imposed upon you by the Administrator or EPA or OMB, or were those your decisions?

Dr. Gage. The decisions came out of our zero-based budgeting review process in the main. I would include the aquatic weeds and the Great Lakes. It was the collective decision of the Assistant Administrators and then confirmed by the Administrator that we not go forward with the continuation of the Great Lakes add-on and the aquatic weeds. This is not withstanding my somewhat fervent pleas that I was going to have to come up here before this committee and catch holy hell for not putting those continuous increases on into 1981; but, nonetheless, it is an Agency decision. Here I am.

Mr. Blanchard. I hate to vent all the hostility on you, but I think what we will do is find some things that are important to your superiors and cut those down in the amounts we need to add to our own projects.

Having said that, I am curious, have you ever visited that Grosse Ile facility?

Dr. Gage. I have not. I have been to the Duluth laboratory—the parent laboratory—a number of times. I have not been to the Grosse Ile station.

Mr. Blanchard. I take it, perhaps, there is a feeling at EPA that they do not do good work. Is that a fair characterization?

Dr. Gage. Certainly not in my estimation. I can turn to Allan, who has just been in a process of visiting our laboratories and ask him to give his assessment as an outsider, up until recently, of the Grosse Ile facility.

Dr. Hirsch. No. I think they do good work.

Mr. Blanchard. Obviously, they are going to tell me they do. I am starting to wonder if the opinion is not otherwise here or somewhere else?

Dr. HIRSCH. I think some of the evidence is reflected in the fact that its findings contributed to things like the phosphate loadings and the Great Lakes water quality agreement with Canada. Some of the work in our Chicago regional office on various toxic problems in harbors and so on stem directly from that laboratory. I do think they do good work.

Mr. BLANCHARD. Do you know how much money is used in research on the Great Lakes by your Agency? How much is devoted to that? I do not assume it is all labeled as such. Could you give me an estimate.

Dr. HIRSCH. From the standpoint of the research, it is specifically entitled Great Lakes. That is in the budget. This year it is about $3.5 million. In the fiscal year 1981, it would be about $1.5 million, but there is a great deal of work that goes on that is applicable to the Great Lakes.

Let's take toxics. A lot of the work that would go on at our Duluth laboratory would have national applicability, such as how a toxic chemical moves through an aquatic food chain and winds up in fish. That is not labeled Great Lakes, as such, and yet it would contribute directly to solving some of the problems in the Great Lakes. So it is hard to give a figure on that.

Then of course we do have a laboratory in our Chicago office that works on technical investigations in the Great Lakes for the region That is not termed research.

Mr. BLANCHARD. I would be happy to receive later in writing the different programs that might relate to the Great Lakes research.

[The information referred to follows:]

Question. You have stated that research on toxic chemicals is being carried out in areas other than in the Great Lakes but that much of this information will benefit the Great Lakes Research Program. Will you describe these other studies and how they relate to the Great Lakes?

Response. Toxics research within the Office of Environmental Processes and Effects is conducted at a number of our laboratories, the largest programs of a relevant nature being at Athens, Corvallis, and Duluth. Studies are carried out on the topics of ecological effects, transport and fate, and characterization and measurement methods development; additional work is done under the Public Health Initiative. Total resources for the entire program for fiscal year 1980 are $10.6M and 42 positions. Some of the specific studies are as follows:

Ecological Effects;
  development standard methods for defining effects of toxic chemicals on aquatic organisms;
  develop microcosms and laboratory model ecosystems for predicting transport, transformation, and effects of toxic chemicals in freshwater environments;
  develop mathematical models for predicting concentration of toxic chemicals in water environments;
  develop methodologies for defining concentration and uptake of toxic chemicals in food chain systems.
Transport and Fate;
  develop test protocols and methodologies for determining biodegradation, adsorption, and leaching of toxic chemicals in water-soil/sediment systems;
  develop screening methods and models for predicting exposure concentration, transport, and fate of toxic chemicals in aquatic environments;
  develop test protocols and methodologies for obtaining data to be used in defining potential bioaccumulation of toxic chemicals;
  develop methodologies for predicting transport and transformation of toxic chemicals in air.
Characterization and Measurement Methods Development:
  develop improved collection methods for toxic chemicals in air;
  develop universal detector for organic toxics measurements;
  develop methods for separation and concentration of trace organics from soil and sediment.

These studies supply valuable information to the Great Lakes Research Program which is examining aerial and surface runoff sources of toxics, sediment adsorption/release phenomena, and transport and fate of toxics in the whole-lake system.

Question. In addition to the research carried out at the Large Lakes Research Station in Grosse Ile, Michigan, what other activities are also focused on the Great Lakes?

Response. There are two other parts to the total Great Lakes research effort within the Agency—the EPA-Great Lakes National Program Office in Region V, Chicago, Illinois and the Department of Energy's Great Lakes Research Program, transferred by OMB directive to EPA in 1979 and now coordinated and managed by ORD/OEPER.

The Great Lakes National Program is funded at $6.5M and 20 positions in FY 80. Specific outputs have been organized to give emphasis to those which, in the near term, address significant point and nonpoint Great Lakes pollution problems including: toxicants, accelerated eutrophication, municipal and industrial discharges, and new or emerging environmental contaminants. The National Program's goal is to better define the Great Lakes pollution problems, to integrate specific actions to abate and control those problems, and to provide guidance and assistance in support of State efforts.

The Energy-related research activity is funded in FY 80 at $1.1M. This program consists of a number of interrelated field and laboratory research projects that are systematically investigating the physical transport, chemical transformation, biological cycling, and ultimate geochemical fate of pollutant materials released to the equatic systems of the Great Lakes drainage basin.

The three components of the Great Lakes studies are closely coordinated to attain an integrated program avoiding duplication and providing outputs of optimum use to the pollution control efforts of the Agency.

Part of the money that we provided last year for that Grosse Ile lab was going toward your grants program. How much staff do you have at EPA that would review various research proposals which will be submitted under that program?

Dr. GAGE. We have already established a small ad hoc group to handle the initial grant proposals, and the total size of that group is about eight people. That is not the critical point. The point is that we have already qualified over 1,000 scientists from around the country to serve on our peer review panels.

We have already set up the first 4 panels, which will consist of about 10 outstanding scientists each in the areas of health effects, ecological effects, control technology, and measurement instrumentation systems.

We have reached out to get the best people possible to review these proposals that are coming in.

Mr. BLANCHARD. Do these people who review the proposals know the source of the submission?

Dr. GAGE. In some cases, very possibly, yes.

Mr. BLANCHARD. Does the proposal identify "Joe Schmo, University of Michigan"?

Dr. GAGE. Yes.

Mr. BLANCHARD. Why do you do that? I mean, if politics is bad, it is usually worse at the university level. Why would you let a group of people dole out a slush fund like that on the basis where you identify the author of the proposal?

Dr. GAGE. Well, a very critical element in the review of the grant applications is the assessment of the capabilities of the principal investigator and his associates to perform the work. Please make it absolutely clear this is not a slush fund.

The other major science funding agencies in Federal Government have found this peer-review process, with all the checks and balances that are built in to keep panel members from reviewing their own applications or those of a colleague, to provide the best overall set of checks and balances against abuse in the award of research moneys.

I point to the National Institutes of Health and the National Science Foundation and the new competitive grant program in the Department of Agriculture. It is not without criticism, but frankly, it has worked in the best interest of the major science agencies in this town ever since World War II. We are not experimenting with an untried formula here, by any means.

Mr. Blanchard. I understand it. You probably mean well. I just caution you. I am not suggesting that you, yourself, want to create a slush fund. But ever since the 1960's we have had contracts and there have been Washington Post articles about these. It is a favorite game. Universities play it probably better than anybody.

Dr. Gage. Consider the downside.

Mr. Blanchard. It is not considered from previous experience in this town to be necessarily a valid way of awarding research money.

Dr. Gage. I understand.

Mr. Blanchard. I am not sure I have a better idea.

Dr. Gage. But please consider the downside, Mr. Blanchard. The past way in which the grants were awarded to laboratories was through very personal and sometimes old-school-tie relationships between laboratory, project managers, and the university researchers. If you want to look for incestuous relationships, look among those sets of relationships. I think what we are trying to do is set up a situation which minimizes the extent to which personal influence comes to bear in the award of a grant.

Mr. Blanchard. I hope it works that way, because neither process is without fault.

When you review these proposals, are the results made public?

Dr. Gage. The results have to be protected, in that the relative ranking of these grants is really a matter of financial decisionmaking by the executive branch.

The awards will, of course, all be made public in the usual fashion, with notice given to the Congressmen in advance of the award to be made to a university.

Mr. Blanchard. If I were a researcher and did not have my proposal accepted, would I be able to find out—would Jim Blanchard be able to find out—how it was reviewed and how it was analyzed?

Dr. Gage. Yes. In fact, the critiques are usually sent back to the individual researchers, and they have a chance to appeal the ranking and answer anything that is in the review package which they think is misleading or which has been misinterpreted.

Mr. Blanchard. In the pamphlets that you put out on this program, you summarize potential studies for the Great Lakes. It seems that most of the emphasis is on phosphorus, not toxics.

Most of the people who work in the Great Lakes consider phosphorus, at this point, of lesser priority than toxics, not the reverse. Is there some reason for that?

Dr. **Gage.** Since the material which we have included in that solicitation was prepared out of the Grosse Isle station and sent through Dr. Hirsch's office before it was combined in this proposal, I would like Dr. Hirsch to answer that question very candidly.

Dr. **Hirsch.** Yes. When you read the format of that grant solicitation, it certainly looks as if the greatest degree of emphasis is being put on phophates. It does also mention things like PCB's getting in from atmospheric transport. If you look at the last paragraph there, it mentions another area. Then item D refers to pollutants other than phosphates. But you are quite right, the appearance is one of a great deal of emphasis on phosphates.

Our feeling was this. Basically, our work in the Great Lakes, as you probably know, is switching from an emphasis on eutrophication and phosphates in the past to one of toxic pollutants in the future.

At the Grosse Isle lab, we have been able to make some progress in modeling phosphates eutrophication relationships. Because eutrophication continues to be an important problem in the Great Lakes, we did think with this new competitive program we ought to take one last look and see if there are any outstanding ideas that would come in by opening this to a wider array of scientists than may have participated in the past. I think that if we don't receive ideas that represent a contribution of some sort, the projects won't be funded and the projects in the other areas will be the grants that do get funded.

Mr. **Blanchard.** Regarding acid rain, the U.S. Government has undertaken with the Canadian Government to sit down and begin to discuss some way—and it is going to take several years—to come to some agreement to deal with the problem of transboundary air pollution.

You had a fairly interesting chart up there earlier. I would like to get a copy of it if I could—No. 1.

I am curious. Are you doing research that is going to be usable in those negotiations? There is some connection between research you might do and the international joint commission which is kind of promoted and watched over by the State Department but, necessarily, they are interested in all the Great Lakes stuff as well as acid rain.

Dr. **Gage.** In fact, the research arm of that bilateral arrangement is staffed by ORD people. The two individuals we have working very substantially on that are Dr. Paul Altschuller, who is on leave this year as the Director of the Environmental Sciences Research Laboratory and who is working on the transboundary transport of pollutants, and Mr. Lowell Smith, who is working on the modeling of the transboundary pollution as well as the control technology options for dealing with acid precipitation over the long haul.

That research working group, Mr. Blanchard, is due with their next report, I believe, on October 1. We would be very happy to keep you posted on that and provide a copy of that when it is done.

Mr. **Blanchard.** Incidentally, you mentioned something earlier that has caused speculation here. You kind of left the hint that you were leaving. Did you mean to do that?

Dr. **Gage.** No; I have no plans whatsoever to leave.

Mr. **Blanchard.** We started speculating that maybe you were going to hang it up.

Dr. **Gage.** No. I actually thrive on this kind of exchange.

Mr. **Blanchard.** In your statement on page 7, you indicated: "We have also decreased emphasis on the transport and fate of toxic organic chemicals in the Great Lakes."

Dr. **Gage.** Yes.

Mr. **Blanchard.** Why should you make such a stupid statement? The reason for it must be it is being handled elsewhere, but you make it sound like you don't think it is that important a problem. I am sure you don't mean that. What do you mean?

Dr. **Gage.** Let me plead guilty for staff and ask Allan to——

Dr. **Hirsch.** I guess the answer is poor staff work for putting that in his statement.

What we meant to say was that the total level of effort that we are putting into toxics, fate and transport work in the Great Lakes is decreasing. That reflects the budget decrease.

Of the remaining budget that we have in the Great Lakes, the vast majority of that is for toxic fate and transport work and so on. Probably about 80 percent or more of the funds that we have in the Great Lakes will be going to that area.

I guess the answer is that it is a clumsy sentence. It is not accurate as written, or it is misleading anyway.

Mr. **Blanchard.** I thought maybe that was just to get me to wake up.

Dr. **Hirsch.** I've already had that sentence called to my attention, Congressman.

[Pause.]

Chairman **Ambro.** Are you awake?

Mr. **Blanchard.** Partially, but I've heard you enough today though.

Chairman **Ambro.** You have not heard the end of me.

Mr. **Blanchard.** I know I haven't.

The last question I have is, if we had to cut $1.6 million or $2 million from your budget, where would you like me to do it?

Dr. **Gage.** I wouldn't want you to do it anywhere.

Chairman **Ambro.** Chrysler Corp.——

Dr. **Reznek.** All the DAA's are pointing at one another.

Mr. **Blanchard.** I don't want to do it on administrative expenses. I am not going to do it there. I think you ought to have all the discretionary platitude that you have to run the department. Where do we do it?

Dr. **Gage.** I can't do anything in all honesty but ask you to turn to the zero-based budget ranking tables that I understand you have copies of and start working from the bottom of the list. I think we have a reasonably fair assessment in there.

Mr. **Blanchard.** Thank you, Mr. Chairman.

Chairman **Ambro.** Thank you, Mr. Blanchard.

I think the answer flows from the budget; aquatic weeds, Great Lakes——

Mr. **Blanchard.** We are going to do it in reverse.

Chairman **Ambro.** Dr. Gage, you are all we have. Why don't we be philosophical and use the Myron Cohen line? 'Everybody has got to be someplace." And here you are.

Just to understand how, once more for the record, budgets are developed and your attitudes about priorities and things like that.

This subcommittee did provide in the authorizing budget $1 million, and so did the Senate, for aquatic weeds research. Six hundred thousand was, indeed, appropriated for aquatic weeds research. What did you do with that money?

Dr. **Gage.** We plan to spend that entire $600,000 on aquatic weed research. I would ask Dr. Hirsch to give a little bit more blow-by-blow on that.

Chairman **Ambro.** In the blow-by-blow, will you talk to the testimony that we received that this program could not be carried out—this is last year—in a year and with the figure that we got, I think, from staff in your office, of $1 million. You got $600,000 for this research in 1980. There is no money now for the following year, so you know where I am coming from when we discuss what you are going to do with this $600,000 and why there is no money in the upcoming budget for it?

Dr. **Hirsch.** With respect to what we are going to do with the $600,000, first of all, let me say that in addition to the $600,000 there is some carryover money from fiscal year 1979. We are doing several things with it. First, we are funding a grant at the University of Florida where they are working on the effects of weed control on a lake there and on aquatic organisms.

Chairman **Ambro.** How much is that?

Dr. **Hirsch.** Roughly, $150,000 as I recall.

Second, we will be issuing a grant solicitation for competitive projects after our conference on aquatic weeds, which is taking place, I believe, on the 27th and the 28th of this month. We will present our draft research approach, which I know we've given to Dr. Marceau, and we have various aquatic weed experts from around the country coming in. After they have given us their advice, we will be going out with grant solicitations in that area, so that will account for, I would think, roughly another $500,000 of funding if and when we get good projects back in response to the solicitation.

Then in addition, we would expect to fund projects that were not committed to the competitive grant mechanism; again, depending on what the outcome of our consultations are at the end of this month.

Chairman **Ambro.** Well, how does that work? If you have $150,000, $120,000, and $500,000, what was the surplus that you used from 1979 to 1980 for this program? Do you remember?

Dr. **Hirsch.** We carried over, I believe, $450,000 from 1979 into 1980. Of that, approximately $135,000 went for the grant that I've described. Relatively small amounts, I think roughly $20,000, stayed with the University of Florida to try to pull together an overview of what information is known about aquatic weeds. Probably another $20,000 or $30,000 will be involved in the conduct of this workshop and in the planning that takes place after that to line out a——

Chairman **Ambro.** What would, therefore, be the total cost of the program as you envision?

Dr. **Hirsch.** The total cost in fiscal year 1980?

Chairman **Ambro.** No; the total cost of the program, however long it takes.

Dr. **Hirsch.** We don't have any. We have a 1-year cost; that is, we are identifying important areas in which to do research, and we are prepared to commit somewhere between $800,000 and $1 million to that in fiscal year 1980. We have no request in fiscal year 1981.

Chairman **Ambro.** That is what I am getting at. You have $400,000 for 1979; you have $600,000 in appropriations in 1980. That is $1 million, approximately. You have nothing in 1981. Now suppose your workshop provides you with additional research in areas in which you consider to have high priority. When you run out of money, do you terminate the program and come back in 1981 for moneys in 1982? How does that work?

Dr. **Hirsch.** Presumably, if they identify a series of things to do that had very high priority, we could enter those into the ZBB process for 1982 and see how they fared.

I should point out that this program is not the only place in which those ideas could be addressed. For example, the clean lakes program has done a certain amount of work relating to aquatic weeds in lake restoration. In the Chesapeake Bay program, it isn't how to get rid of the aquatic weeds, it is why the aquatic weeds are disappearing of their own accord from the Chesapeake, so I guess they are a mixed blassing in that regard.

What I am saying is that, depending on the ideas that come out of that conference, some of those may fit very well in some of those other areas. At this stage, we just don't know.

Chairman **Ambro.** Well, what I am getting at, I suppose, is do you see a continuity in funding for this program even when or after your workshop indicates that there are areas to be given high priority or by virtue of your not requesting funds in the fiscal year 1981 budget? Will there be a hiatus in the program?

Dr. **Hirsch.** What I would say we do is look at the recommendations or the projects that come out of that workshop. If we can't do a good job on addressing those with $1 million, I am sure we will take the surplus or the overage that is unfunded and we will enter that into our ZBB process.

I guess I would say that, if it fared, as it fared in fiscal year 1981, I wouldn't give it very high percentage points of reaching a top priority.

Chairman **Ambro.** OK. That's why I wanted to use the example.

I said at the outset that the House provided $1 million in authorization and the Senate went along. You have $600,000 in appropriations, all of which indicates the intent of Congress.

Now what does the intent of Congress mean in assigning priorities to that which you do? The Corps of Engineers has a program for aquatic weeds, incidentally, as we all know—that is to kill all aquatic weeds.

We decided that that was not the proper way to go, and so a couple of us decided that we would ask an environmentally concerned organization to do a little looking.

So tell me where does congressional intent come in, in the assigning of priorities to programs?

Dr. **Gage.** Well, it comes in a variety of ways. I am going to speak to this in a more general fashion just for a second.

The message which you gave us through the Research and Development and Demonstration Authorization Act is one of a number of messages which we take into our very earnest budgeting processes. I have to say very frankly that, in some instances, that does not carry as much weight as instructions which come from the appropriation committees in connection with certain work that has been ordered by the appropriation committees.

Chairman Ambro. That is the congressional intent. Let me interrupt you; $600,000 voted by both the House and the Senate said yes, to this program, but at a lower level of funding, so you still have the same kind of intent.

Dr. Gage. We are spending that money. What the Appropriations Act did not address—and this may sound like a weasel, but it is in fact the case—the fact that this would be a continued program for any period of time. So, therefore, we went into our budgeting process this past year to develop our 1981 budget, and we were faced with the problem—you go ahead and spend the $600,000, but there are too many other higher priority activities in the Agency that will crowd that off the agenda.

Chairman Ambro. When you are looking at zero-based budgeting and your making your statements thereto, does anyone ever say that those people on the Hill are interested in this program? Maybe we ought to, on a scale of 1 to 10, give it one point for congressional intent, or is that a part of the ZBB process?

Dr. Gage. It very much is a part.

Chairman Ambro. Who is the guy that discounts it?

Dr. Gage. I think we probably are all guilty. Those of us who are in the decisionmaking process are putting up a fairly large discount factor on each other's claims, because there are many, many claims to the budget, and we ended up with two.

You may consider it egregious examples of where programs that you have added in were not continued. Yet, there are a number of other examples where programs that were started——

Chairman Ambro. You know what I consider egregious—that we spend so much time arguing about a $1 million aquatic weeds program and an acid rain program which, again, I will regale you with comment from the press release from the White House. Guess what—it says: "Acid rain has made many lakes, particularly in the northeastern United States, lethal to fish and other aquatic life." And it goes on to indicate the horrors of acid rain, which we pressed for last year.

What is egregious is the budget and the numbers we are talking about. A spike or a flange on an F-14 would pay for the aquatic weeds program. A tire on an A-10 would pay for the acid rain program.

You have moved from $342 million up 8 percent, to $368 million in fiscal year 1981. Who is it in OMB who is so unaware of environmental impacts that will result from these tens of thousands of compounds being dumped into waters that is so unconcerned about air quality as the result of the shift to coal. Who is so unconcerned about all these things that we have to wrangle over a couple of million dollars; and, if the right-wing wants to put that in some kind of commentary on me, do it.

I just can't see how the kinds of money we are talking about for so vital a number of programs is missing from these budgets. Why don't you go in there and pound the table—beat on OMB?

Dr. Gage. We do.

Chairman Ambro. Or whomever.

Dr. Gage. We do. We can't make all the people happy all the time, Mr. Chairman.

Chairman AMBRO. Well, tell me, once OMB reviews the budget and cuts whatever they decide is not significant, is that the budget that comes here?

Dr. GAGE. Yes; after the appeals process, which sometimes means we go back in and lose a little more blood and skin and hair.

Chairman AMBRO. So in answer to Mr. Blanchard's question, we will either be heros or goats by adding or subtracting from this budget, depending upon our own personal views of which way your division should tilt.

Dr. GAGE. There is a certain jaundiced view that has it that way.

Chairman AMBRO. Well, we don't mind doing it. It might look like what you have submitted this time; however, for example, in anticipatory research, why did you establish that category?

Dr. GAGE. I didn't. My predecessor did as, from what I understand, sort of an entree to be responsive to the Congress in pushing for more long-term research.

Chairman AMBRO. If I can engage in literary license, do you, as the royal you, as you sit there as you, your predecessor did it?

Dr. GAGE. Yes.

Chairman AMBRO. Suppose we said this: That, since anticipatory or the word conjures up such horrors in the minds of Members on the floor, thinking that they are little sneakered people in ivory towers looking off into the future, whereas in fact what we are dealing with is acid rain and groundwater in anticipatory; correct?

I see your budget man nodding.

What would be the difficulty in saying—the heck with anticipatory and line iteming or categorizing in these other categories moneys for groundwater and for acid rain in a medium maybe or some other place, so that the perjorative connotation of the word anticipatory is no longer with us, and we don't have to fight in the well all those people who can't even pronounce it.

Dr. GAGE. Frankly, it would make our life easier, if it is done carefully.

Chairman AMBRO. I am asking you to do it then, and we won't have to. It would make us both happy. Can you develop an anticipatory program, splitting up the anticipatory in the other areas?

Dr. GAGE. Certainly; it was created as a budget artifice that we have been living with for the last 4 years, and so it can disappear as a budget artifice.

Chairman AMBRO. Well, I'd make that suggestion.

Dr. GAGE. Very frankly, we have been faced with the other side of the problem which is that we cannot make significant changes in our budget structure, unless we go back and get congressional approval. That is one of the reasons why I have fought even harder to get the anticipatory program reprogramed, to change it around to another structure.

Chairman AMBRO. You remember what happened last year?

Dr. GAGE. Yes, I do.

Chairman AMBRO. We tried to get the Appropriations Committee to restore that $6 million in anticipatory which they cut out. They would not do it. Guess what? Of all people, "Golden Fleece" did it and restored $6 million for a problem that was, without question——

Mr. BLANCHARD. Who? What did you call him?

Chairman **Ambro**. Senator Proxmire. A great man. "Golden Fleece."

I must tell you there are a number of specific technical questions that I have concerning this budget, but I think the conceptual attitudes that we articulated and that we tried to drive home, maybe in a less than amicable manner, have indeed been driven home. You have been very kind and patient. We will submit those specific questions to you for the record, and ask you to respond quickly.[1]

Again, we make the offer that, instead of trusting to the U.S. Postal Service, when the answers are developed, we will send someone over to pick them up so that it is not 3 weeks before we get the answers.

Dr. **Gage**. We will bring that to you.

Chairman **Ambro**. I thank each of your colleagues for being so patient with us. We are rather exercised over portions of this budget and some of the deletions which have particular meaning to some members; but, as usual, you handle us and the questions you fielded very well.

We hope, each of us, that you don't leave because, at least, we know you. God knows what might happen after you.

Mr. **Blanchard**. Yes, Mr. Chairman, if you will yield.

We certainly want to have Steve Gage around to kick around next year.

Mr. Chairman, I am just curious as to how many people in the audience work for EPA?

Dr. **Gage**. They didn't want to miss this show.

Mr. **Blanchard**. If I had known that, I would have had more questions, but we will leave it at that. Thank you.

Chairman **Ambro**. All members of the subcommittee can, indeed, submit questions, plus the staff questions, and we will get them over to you as soon as possible to round out the hearing record.

Once more, thank you very much.

[Whereupon, at 5:30 p.m., the hearing was adjourned.]

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[1] See app. 4.

1981 AUTHORIZATION FOR THE OFFICE OF RESEARCH AND DEVELOPMENT, ENVIRONMENTAL PROTECTION AGENCY

WEDNESDAY, FEBRUARY 20, 1980

House of Representatives,
Committee on Science and Technology,
Subcommittee on Natural Resources and Environment,
Washington, D.C.

The subcommittee met, pursuant to notice, at 4:05 p.m., in room 2325, Rayburn House Office Building, Hon. Jerome A. Ambro (chairman of the subcommittee) presiding.

Chairman **Ambro.** I would like to open this meeting and say that, today, the Subcommittee on Natural Resources and Environment continues its oversight of the Environmental Protection Agency and its review of the fiscal year 1981 budget request for research and development by hearing testimony from four public witnesses.

We call these public witnesses not because we expect them to provide us with an analysis of EPA's budget, although they are free to do that, but rather because each of them has particular expertise which we believe will provide very useful guidance to us as we proceed with our markup of the authorization of EPA's R. & D. program.

Let me say that, because we will be hearing from several witnesses and we would like to leave ample time for discussion, we ask the witnesses to limit their oral statement to no more than 10 minutes. We will, of course, include witnesses' prepared statements in full in the record.

I would like to ask our colleagues if they would like to make any opening statements.

Mr. Walker?

Mr. **Walker.** No opening statements, Mr. Chairman.

Chairman **Ambro.** Mr. Brown?

Mr. **Brown.** No; thank you.

Mr. **Blanchard.** Only, Mr. Chairman, that I want to welcome Dr. Vostal of General Motors who is here.

I have often been accused recently of being the Congressman from Chrysler. Considering the fact that people from my congressional district don't work for Chrysler and don't work for auto companies, at least I have the opportunity to welcome someone from one of the competitors. I look forward to your testimony and, also, point out that most people in my district are concerned about clean air and clean health, as well as selling automobiles.

I think, perhaps, Dr. Vostal has something to say about that of interest to all of us.

Thank you, Mr. Chairman.

Chairman **Ambro.** Thank you, Mr. Blanchard. I might say at the outset that we will call each witness separately and question them separately. That will give you one more opportunity to welcome Dr. Vostal. [Laughter.]

Mr. **Blanchard.** Do I have 10 minutes to do that?

Chairman **Ambro.** You have as much time as your little heart desires.

With that, I would like to welcome our first witness, Dr. George Hendrey, who is the Director of the Land and Fresh Water Environmental Group at the Brookhaven National Laboratory.

Dr. Hendrey will speak to us on the subject of acid rain research. Acid rain is a complex problem that is becoming worse as we move toward the utilization of more coal. Therefore, we are most interested in hearing about the research needs that must be met to abate this problem.

Dr. Hendrey, we thank you for being here with us today. You may proceed within the constraints I outlined at the outset in any way you think most appropriate.

STATEMENT OF DR. GEORGE R. HENDREY

Dr. **Hendrey.** Thank you, Mr. Ambro and colleagues.

I am honored to be invited to present my views of temporal perspectives on acid deposition research. As I understand it, the need is to find out, not specifically what topics are to be investigated, but rather how the general area of acid rain research ought to be conducted.

The phenomenon of acidic precipitation is widely recognized as a major environmental problem by this committee through your access to a variety of information sources. I don't want to review those things in toto right now, but I would like to clarify the definition of acid precipitation or shall I call it acid rain. Acid rain includes fog, rain, dew, and snow with strong acid concentrations in excess of 2.5 micro equivalents per liter, which is a pH of 5.6.

Acid rain also includes the deposition of particulate matter, such as ammonium sulfate aerosols, and other aerosols which may contain toxic metals or toxic organic substances, and the deposition of gases such as sulfur dioxide and NO_2. Acid rain is differentiated from other types of atmospheric pollution, primarily by its distance from identifiable sources, and by having sulfuric and nitric acids as the principal contaminants impacting regions remote from emission sources. Rain and snow in the United States east of the Mississippi River is always acidic (pH 5.0 to 4.1) on an average annual basis and, in fact, we even see acid rain in Hawaii and in regions such as Bermuda where pH's of less than 4.5 may occur on a seasonal basis.

Acidification of lakes is reported in a variety of regions, including the Adirondack Mountains, Maine, Florida, and Washington State, indicating the widely dispersed nature of acid rain.

I have recently made some data collections and collated this information against all data that was taken several decades ago along the Blue Ridge Mountains in North Carolina. These data—if I can see figure 1, please—indicate that streams in this region have also been acidified. What this data shows, on the vertical axis to the left, is the alkalinity values determined this past summer and, on the horizontal axis at the bottom, alkalinity values determined in the 1960's to 1964.

The diagonal line represents a line of equal value. If there were no change in these measurements, they would all fall on that line.

We know the old method of measuring alkalinity provided an error which was not in excess of 40 micro equivalents per liter; and, so by drawing the diagonal, as I have in a dash form, we correct for that error so that our methods of measuring are exactly equivalent. What you see is a very substantial acidification, a loss of alkalinity of these North Carolina streams.

The next slide, please, with a similar appearance.

This figure shows the corresponding pH drop in these streams. Those methods were quite similar so that we need to draw only one diagonal line. What you see is that the pH measured in these streams is much lower now than it was in the 1960 to 1964 time period.

Similar kinds of information have been derived for the State of Maine, and our survey which we recently completed for EPA indicates that injury of this kind; that is, acidification of watersheds is widespread over the Eastern United States.

Now the impact of that acid precipitation on the productivity of forests, if there is any impact, is either so slight that we can't measure it or has a long period of latency, that is, injury which occurs but is not measurable until some later date when a secondary or, perhaps, a primary effect on forest productivity might be observed.

One latent impact is the decreased nutrient availability due to accelerated leaching of nutrients from soils by acid input. One set of evidence that long-term nutrient depletion is occurring in acid impacted areas has been obtained in Nova Scotia.

These figures show pH decreasing as you go up on the Y axis and calcium decreasing as you go to the left on the X axis. What you see for 11 Nova Scotia rivers is a remarkable decrease in pH, while at the same time calcium is decreasing.

Normally when watersheds receive acid, some of the acid exchanges for calcium, magnesium and aluminum; but, as the acid is absorbed into the watershed these cation materials are washed out.

Here we have, instead of an increase in these rivers, we see a decrease, despite increased acid loading.

The implication is that available calcium, a readily weatherable material, has all been depleted, and we are now removing only the residue. This is by implication a permanent injury—and we can discuss things in human perspective—a permanent loss by implication of essential forest nutrients from these soils. There is little other data of this kind currently available regarding the impact of acid precipitation on forests.

Studies like these that I have just shown you demonstrate the insidious long-term effects of chronic acid deposition. Other changes may be occurring which are not yet visible and which can only be observed following a very long period of observation.

That brings us to research needs.

The overriding objective of research conducted by the Government agencies that I have been associated with—the Department of Energy, the Department of Agriculture, the Environmental Protection Agency, NOAA, and others—is to obtain information for regulatory purposes. Currently, regulatory decisions concerning emissions of atmospheric pollutants to control acid rain must be made without the benefit of knowledge as to whether or not crops and forests are seriously impacted by acid rain; whether or not experimental evidence of injury can be used to calculate actual agronomic and forestry loss; whether or not reductions of emissions from several regional sources will produce a desired level of abatement of acidic conditions in the surface waters of a receptor region; or even whether or not the effects of soil acidification are reversible within the span of a human generation or on a scale of geologic time. We simply don't know the answers to those kinds of questions.

Several reports have been presented in the past 2 years which make specific recommendations for research. I have provided these in a table, which is currently in the mail to the technical staff of the committee. Rather than go into these specific definitions, I would rather note certain areas or types of research that ought to be addressed.

These are the long-term monitoring of precipitation chemistry, the definition of areas of impact, the broadening of the impact data base, dose response functions, systems studies, and economic assessments. These six study areas will require different research management approaches. The long-term monitoring and precipitation chemistry will require an initial intensive effort for several years to establish and calibrate the monitoring and analytical system and to analyze the initial rush of data as it comes in.

Defining areas of impact through long-term monitoring requires long-term stability in the research project. By this, I mean, more than 10 years for this type of research activity.

Defining areas of impact is currently underway, based on the available deposition chemistry. Several studies have identified sensitive areas and areas at risk. By that, I mean areas which are both sensitive and currently receiving acid inputs. The scales of resolution vary from a county level analysis to the whole of the North American continent, and these are available in the literature. This type of work is of a short-term nature, with projects lasting typically a few months to as long as 1 year or, perhaps, 2 years. Economic assessments are based primarily on existing data, and they can be performed rather quickly. For management purposes, these kinds of projects are seen as short-term or quick-response projects—studies of 6 months to 2 years. Long-term stability is not required to conduct those kinds of analyses.

Dose-response studies at first may appear to be quick-response type studies; for example, the investigation of the tolerance of a particular adult organism to acid. That kind of test can be done in months or less. But many organisms have life spans that are 1 year or many years long. We know now that some of these organisms are injured, not only in the first generation, but in subsequent generations through a failure of reproductivity.

Chronic exposure to low pollutant levels may not produce the immediate mortalities, and so longer term types of experiments are required in order to assess those types of damages. I refer to these as intermediate-term stability in research—that is 2 to 5 years.

Now systems studies are those dealing with assemblages of components. For example, plant physiology, aquatic ecosystems, soil microbial ecosystems, or forest ecosystems, all contain many components. To understand those things requires a great deal of time. We do not yet understand the relationship between acid loading and chemical response within a watershed, let alone the response of the biota.

These studies cannot be accomplished in a short-term management atmosphere. An intermediate-term perspective, in some cases, is sufficient; that is, part of the work can be done in, say, 2 to 5 years. But the really great value of ecosystems studies takes a long time. The Hubbard Brook case is an example. The great value of the Hubbard Brook's study, a well-known ecological effort, has come after 15 years of continuous study. One of the reasons for that is that nature is extremely variable. Nature does not respond like a solution in a bottle. You simply change the chemistry, stick in a probe, and measure the consequences. Nature is variable because of the amount of solar input, because of the amount of rain input, because of the variety of positions in which organisms can grow throughout the watershed.

So long-term response studies—5 to 10 years—are required to understand what is happening in ecosystems.

If a regulatory goal is to obtain a balance between the losses due to watershed acidification—I mean economic and aesthetic losses—and the costs associated with reducing emissions of acid-forming materials, then you must have an understanding of the interaction between the pollutants and the receptor ecosystems; knowledge of the response and consequent interaction among the ecosystem components is essential to determine the degree of relief that ecosystem needs as you set about to determine an abatement strategy.

Both ecologists and managers of large corporations have noted that there is strength in diversity. If there is to be a multimillion dollar research program on the topic of acid deposition, then I urge you to diversify its management. Match the management needs of the various types of research with management agencies best suited for each task. Concentrating all of the research effort under a single agency or even a single directorate selected from among agencies may stifle a desirable diversity in management approaches, hence in the research effort. I urge you to provide for the long-term stability required for ecosystem research as well as for the quick response appropriate to state-of-knowledge questions.

After all, it is the biotic response in the ecosystems that stimulates our interest in acid rain research at all, the loss in crops, forests, and aquatic systems.

Thank you.

[The full prepared statement of Dr. George R. Hendrey, Brookhaven National Laboratory, Upton, N.Y., is as follows:]

TEMPORAL PERSPECTIVE ON ACID DEPOSITION RESEARCH

by

George R. Hendrey
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FTS 666-3262

presented to

Subcommittee on Natural Resources
Committee on Science and Technology
U.S. House of Representatives

February 20, 1980

The phenomenon of acidic precipitation is widely recognized as a major environmental problem in northern Europe and North America. This committee has previously obtained information on the sources of acidic precipitation, its chemical nature and geographic distribution, so it is not necessary to review these topics *in toto*. I will, however, give my definition of "acid rain," present some new data on the regional and temporal nature of the problem, and then discuss research needs.

There is some confusion as to what is meant by the popular generic term "acid rain." "Acid rain" includes rain, fog, dew and snow with strong acid concentrations in excess of 2.5 micro equivalents per liter (μeq/ℓ), which is a pH of 5.6. "Acid rain" also includes the deposition of particulate matter, such as ammonium sulfate aerosols, and other aerosols which may contain toxic metals or organic substances, and the deposition of SO_2 and NO_2 gases. "Acid rain" is differentiated from other forms of air pollution, primarily by distance from identifiable sources and by having sulfuric and nitric acids as the principal contaminants impacting regions remote from emission sources. Rain and snow in the United States east of the Mississippi River have average acid concentrations of from 10 to 80 μeq/ℓ (pH 5.0 to 4.1) (Likens et al. 1979).

New findings on regional acidification

Acidification of lakes is reported in the Adirondack Mountains (Schofield 1976), Maine (Davis et al. 1978), Florida (Brezonik, pers. comm.), and Washington State (Gillion and Horner 1977). Recent observations (Hendrey et al. 1980) demonstrate that streams in the Blue Ridge Mountains of North Carolina have become acidified as well. Data on stream alkalinity and pH, collected in the period 1960-1964 are compared to data collected in 1979 in Figures 1 and 2. If no change in pH were observed, the values would fall on the solid diagnol line in Figure 2. An obvious pH decrease was observed.

Methods used for measuring alkalinity in the earlier data result in an overestimation of about 40 μeq/ℓ. The dashed line in Figure 1 is the line of equal value for alkalinity with the older data reduced by 40 μeq/ℓ. Eighty percent of the streams have been acidified (lost alkalinity). We observed similar acidification of waters in New Hampshire and we suspect that an examination of existing data would reveal a pattern of acidification in many other areas of the eastern United States.

The impact of acidic precipitation on the productivity of forests, if there is any impact, is either so slight that it cannot be measured by existing techniques, or has a long period of latent injury before measurable impacts are detected . One latent impact is decreased nutrient availability due to accelerated leaching by acid inputs to the soil system. One set of evidence that long-term nutrient depletion is occurring in acid impacted areas has been obtained in Nova Scotia. Between 1954-1955 and 1969-1977, the observed pH values and calcium concentrations of eleven rivers dropped considerably (Figure 3). Watershed acidification causes an acceleration in mineral weathering rates and the concentrations of calcium, magnesium and aluminum in stream waters are observed to increase (Gjessing et al. 1976). The implication of the reduced calcium concentrations observed in the Nova Scotia rivers, while acidity increases, is that the watersheds have already lost their most available calcium and that permanent depletion of plant nutrients is occurring.

Studies like these demonstrate the insidious long-term effects of chronic acid deposition. Other changes may be occurring which are as yet completely unnoticed and which may have deleterious impacts on ecosystems and other aspects of "welfare."

Research Needs

The overriding objective of acid deposition research is to obtain information for regulatory purposes. Currently, regulatory decisions concerning emissions of atmospheric pollutants to control "acid rain" must be made without the benefit of knowledge as to whether or not crops and forests are seriously impacted by "acid rain"; whether or not experimental evidence of injury can be used to calculate actual agronomic and forestry losses; whether or not reductions of emissions from several regional sources will produce a desired level of abatement of acid conditions in the surface waters of a receptor region; or even whether or not the effects of soil acidification are reversible within the span of a human generation or on a scale of geologic time.

Several reports have been presented in the past two years which make recommendations concerning specific research needs. These reports are described in Table 1* and the reports have been submitted separately to this committee. Rather than provide a new listing of specific recommendations, I will discuss management considerations for the six general types of research on acid deposition and its environmental impacts listed in Table 2.

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*A new listing of research priority will also appear next month in a report by the Interagency Acid Rain Coordinating Committee (cochaired by EPA and DOA) under the title Federal Acid Rain Assessment Plan.

These six study areas will require different research management approaches. The long-term monitoring of precipitation chemistry will require an initial intensive effort for several years to establish and calibrate the monitoring and analytical system, and to analyze the initial rush of data. The National Atmospheric Deposition Program, now underway, is establishing such a system. It will eventually require an open-ended commitment to a stable monitoring program, much as weather data are collected. The key management words are long-term stability (more than ten years).

Defining areas of impact is currently underway, based on the available deposition chemistry data (e.g. Likens et al. 1979). Several studies have identified sensitive areas and areas at risk (sensitive and exposed to acidic deposition) with various scales of resolution, from continental (Galloway and Cowling 1978; Likens et al. 1979) to the county level (Hendrey et al. 1980). This type of work is of a short-term nature, with projects lasting a few months to a year or two. Economic assessments are based primarily on existing data, so they can be performed rather quickly. For management purposes these are seen as short-term or quick response studies (less than two years). Long term stability is not required.

Dose-response studies may at first also appear amenable to quick response, short-term management, and in some cases this may be possible (e.g. acute LD_{50} studies on aquatic organisms). But many plants which are suspected of being sensitive, and aquatic animals which are sensitive to acid-stress may have life cycles lasting several years. Chronic exposures to low pollutant levels may not produce immediate mortalities. Stress induced by acid or other toxic substances may impact at an unknown point in the life cycle or even by failure to produce a following generation (e.g. Beamish 1974). Systematic dose-response studies, such as a plan for experiments dealing with crops, following standard agronomic practices and producing statistically valid results, require a perspective of several years. The management strategy required is intermediate-term stability (2 to 5 years).

Systems studies are those dealing with assemblages of components. For example, plant physiology, aquatic ecosystems, soil microbial ecosystems, or forest ecosystems, all contain numerous components. The acid deposited into a watershed reacts with many components of the terrestrial ecosystem and then with those of the aquatic ecosystem. We do not yet understand the relationship between acid loading and chemical response, let alone biotic response. These studies cannot be accomplished in a short-term management atmosphere. An intermediate-term perspective is sufficient in some cases. However, long-term (5-10 years) studies of lakes in calibrated watersheds are given high priority for research. These may be initiated and produce useful information with an intermediate-term perspective, but their real value will appear after many years of study (e.g. as in the Hubbard Brook Experimental Forest, Bormann and Likens 1979). If a regulatory goal is to obtain a balance between the losses due to watershed acidification and the costs associated with reduced emissions of acid-forming materials, then one must have an understanding of the interaction between the pollutants and the receptor ecosystems; knowledge of the response and consequent interaction among ecosystem components is essential.

Both Ecologists and managers of large corporations have noted that there is strength in diversity. If there is to be a multimillion dollar program of research on acid deposition, then diversify its management. Match the management needs of the various types of research with management agencies best suited for each task. Concentrating all of the research effort under a single agency or directorate may stifle a desirable diversity in management approaches, hence in research effort. Provide for the long-term stability required for ecosystem research as well as for the quick-response appropriate to state-of-knowledge questions.

References

Schofield, C. L. 1976. Acid Precipitation: Effects on Fish. Ambio 5:228-230.

Davis, R. O., M. O. Smith, J. H. Bailey, and S. A. Norton. 1978. Acidification of Maine (U.S.A.) Lakes by Acidic Precipitation. Verh. Int. Verein. Limnol. 20:532-537

Gillion, R. and R. Horner. 1977. Bear Lake: Current Status and the Consequences of Residential Development. Unpublished manuscript. University of Washington, Seattle.

Hendrey, G. R., J. N. Galloway, S. A. Norton, C. L. Schofield, P. W. Shaffer, and D. A. Burns. 1980. Geological and Hydrochemical Sensitivity of the Eastern United States to Acid Precipitation. EPA-600/3-80-024 (in press).

Gjessing, E. T., A. Henriksen, M. Johannessen, and R. F. Wright. 1976. p. 64-85 in F. H. Braekke ed. Impact of Acid Precipitation on Forest and Freshwater Ecosystems in Norway. FR 6/76, SNSF Project 1432 Aas-NLH Norway.

Likens, G. E., R. F. Wright, J. N. Galloway, and T. J. Butler. 1979. Acid Rain. Sci. Am. 241(4):43-52.

Galloway, J. N. and E. B. Cowling. 1978. The Effects of Precipitation on Aquatic and Terrestrial Ecosystems: A Proposed Precipitation Chemistry Network. APCA Journal 28(3):229.

Beamish, R. J. 1974. Loss of Fish Populations from Unexploited Remote Lakes in Ontario, Canada as a Consequence of Atmospheric Fallout of Acid. 1974. Water Res. 8:85-95.

Table 1. Four recent reports providing recommendations for research on "Acid Rain."

- Ecological Effects of Acid Precipitation.

  Report of a workshop held at Galloway, U.K., 4-7 September 1978. EPRI SOA77-403. M. J. Wood, ed. Prepared by Central Electricity Research Laboratories (Kelvin Avenue, Leatherhead, Surrey, KT22 7SE, U.K.) for Electric Power Research Institute (3412 Hillview Ave., Palo Alto, CA 94303).

  Comment: Workshop of 45 scientists organised to review existing knowledge and identify major areas of uncertainty.
  Principal topics: rain, snow and dry deposition; interactions between deposition, vegetation and soils; soil chemistry; effects on surface waters and aquatic ecology; effects of acid waters on fish; land-water interactions; modeling and synthesis.

- Limnological Aspects of Acid Precipitation.

  Report of the international workshop at Sagamore Lake, New York, September 25-28, 1978. BNL 51074. G. R. Hendrey, ed. Sponsored by Corvallis Environmental Research Laboratory, US-EPA, and Brookhaven National Laboratory, US-DOE.

  Comment: Workshop of 20 scientists expert in the topic area. The goals were to take stock of limnological projects in progress, to identify and prioritize research topics needing further investigation, and to discuss chemical and biological methods and methodological problems.
  Principal topics: pH and acidity measurement; regional lake surveys; aluminum chemistry in dilute waters; chemical budgets, and watershed acidification; benthic organisms; biological processes, toxicity of metals; liming.

- A National Plan for Assessing the Problem of Atmospheric Deposition (Acid Rain).

  A report to the Council on Environmental Quality. National Atmospheric Deposition Program NC-141. J. N. Galloway, E. B. Cowling, E. Gorham, and W. W. McFee.

  Comment: Report prepared at the request of CEQ, has two objectives, (1) to assess the scope of available knowledge about atmospheric deposition and its effects on agricultural lands, forests, ranges, parks surface waters and aquatic life in the U.S. and (2) to recommend a coordinated program of research and monitoring necessary to serve as a basis for management of atmospheric emissions and amelioration of adverse effects on plant and animal life.
  Principal topics: Atmospheric deposition; aquatic and wetland ecosystems; terrestrial vegetation; soils; outputs from terrestrial and aquatic ecosystems.

Effects of Acid Precipitation on Vegetation, Soils and Terrestrial Ecosystems.

Report from the International Workshop at Brookhaven National Laboratory June 12-14, 1979. BNL (in press). L. S. Evans and G. R. Hendrey, eds. sponsored by Corvallis Environmental Research Laboratory, US-EPA, and Brookhaven National Laboratory, US-DOE.

Comment: Workshop of 27 scientists expert in the topic area. The objectives were to determine (1) current knowledge of the effects of acid precipitation on vegetation, soils and terrestrial ecosystems, (2) research needed to understand environmental impacts, and (3) to help coordinate research groups to avoid excessive duplication of effort.
Principal topics: Mechanisms of foliar injury; characterization of foliar injury; metabolic effects of acid rain on foliage; chemical effects on soils; biological effects on soils; impacts on crops; impacts on forest ecosystems; state of knowledge and research priorities.

Table 2. Research topics recognized as essential to providing information needed for the intelligent regulation of "acid rain" problems.

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1. Long-term monitoring of precipitation chemistry
    - temporal changes
    - geographic changes
2. Defining areas of impact
    - deposition monitoring
    - identification of sensitive areas
    - identification of areas at risk
3. Broadening of impact data bases
    - collation of existing data on water and soil chemistry
    - temporal trend analysis
4. Dose-response functions
    - soils
    - aquatic organisms
    - crop plants
    - forest plants
5. System studies
    - plant physiology
    - aquatic ecosystems
    - soil chemical systems
    - soil microbial systems
    - forest ecosystems
6. Economic assessments
    - crops, forests, fisheries
    - recreation, aesthetics
    - structural corrosion
    - waste management alternatives for SOX, ROX and NOX

Figure 1. Comparison of alkalinity data collected in the period 1960-1964 to data collected in 1979. The solid diagonal line represents equal values. The dashed line represents equal values when the old data is corrected by subtracting 40 µeq/ℓ (from Hendrey et al. 1980).

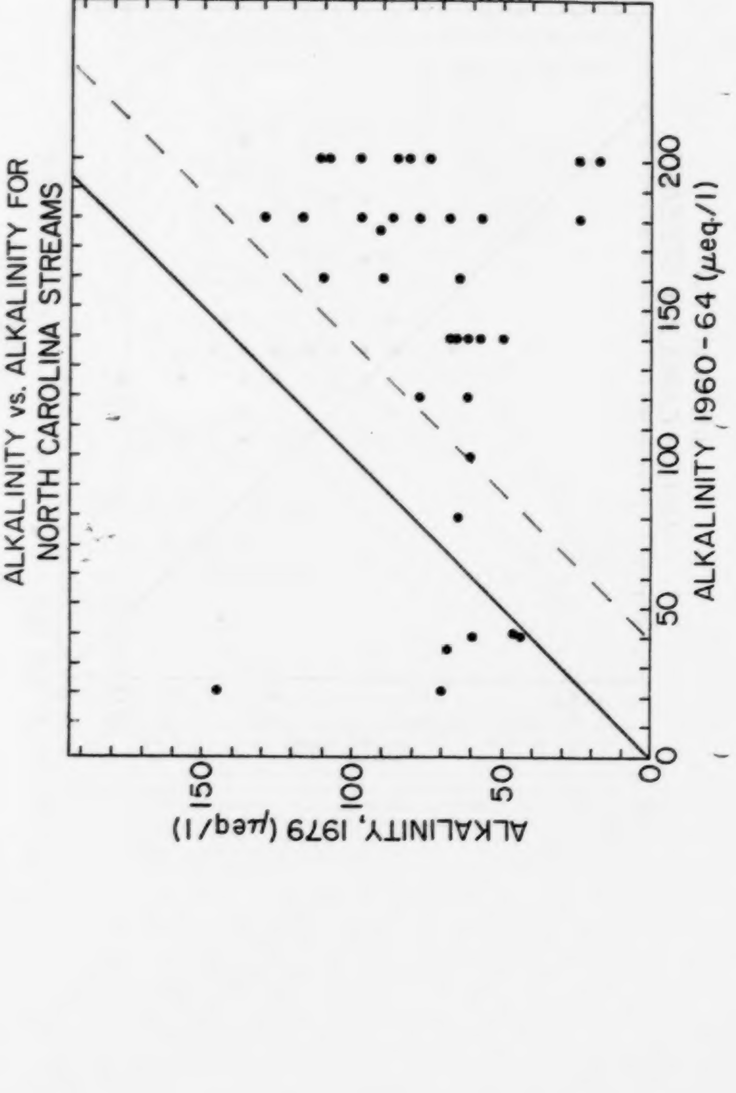
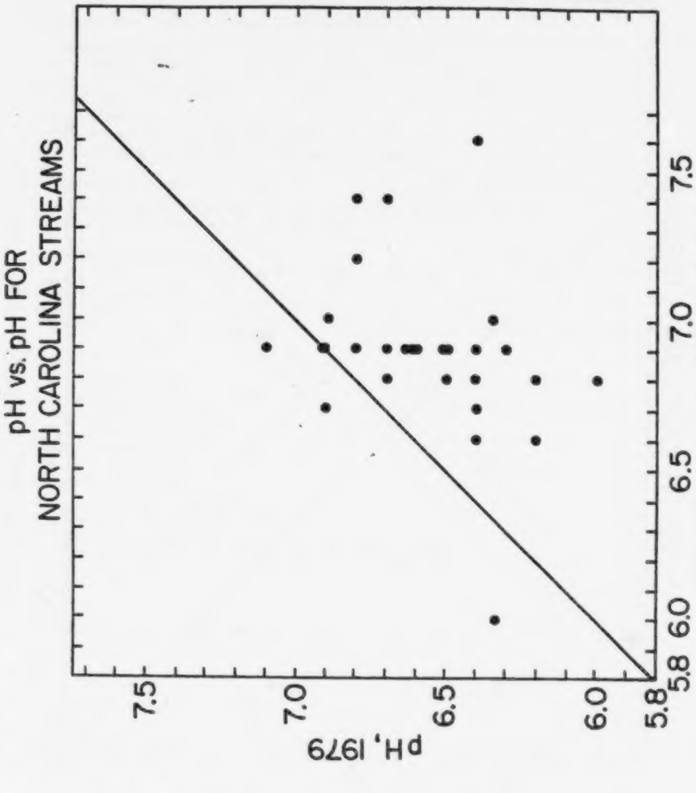


Figure 2. Comparison of pH data collected in the period 1960-1964 to data collected in 1979. The diagonal line represents equal values (from Hendrey et al. 1980).



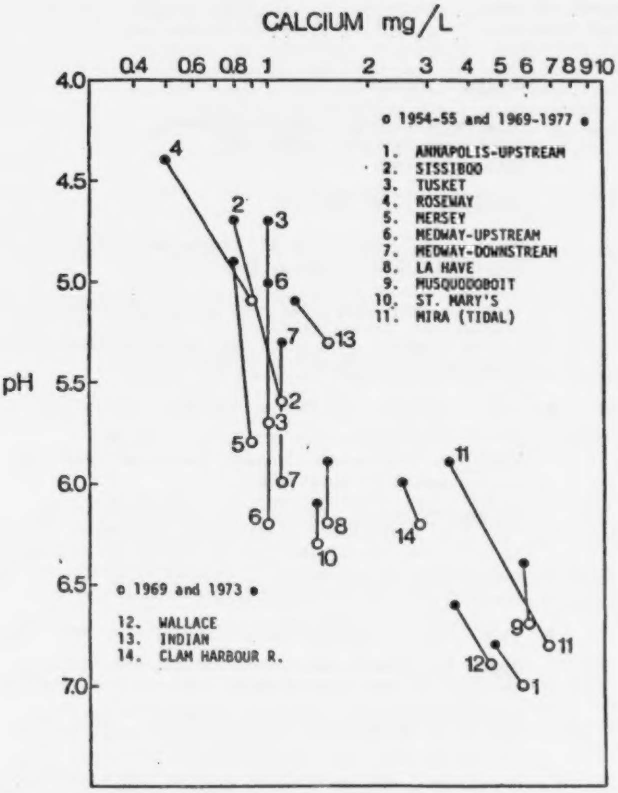


Figure 3. Changes in the pH and calcium concentration observed in several Nova Scotia rivers between 1954 and 1977. (Data for 1954-55 from Thomas, J. F. J. 1960: The Atlantic Provinces and the St. John River drainage basins in Canada, 1954-56. Water Survey Report No. 11, Industrial Water Resources of Canada, Dept. of Mines and Technical Surveys, Ottawa and 1969-77 data from National Water Quality Data Bank, Department of Environment, Water Quality Branch, Ottawa. The figure was produced by Dr. M. E. Thompson, Canada Centre for Inland Waters.)

CURRICULUM VITAE

Name: George R. Hendrey

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Brookhaven National Laboratory
Upton, New York

Telephone (516) 345-3262

Education: Ph. D., 1973, Water and Air Resources Division, University of Washington, Seattle.

Major in aquatic biology with minors in limnology and statistics. Dissertation title: PRODUCTIVITY AND GROWTH KINETICS OF NATURAL PHYTOPLANKTON COMMUNITIES IN FOUR LAKES OF CONTRASTING TROPHIC STATE.

Employment history:

- 1977 - current: Brookhaven National Laboratory Upton, New York.

  Position: Ecologist. Leader, Land and Freshwater Environmental Sciences Group.

  Responsibilities: Planning and coordination of research, development of research proposals, allocation of funds and facilities, for a variety of biological and ecological projects. Principal Investigator for terrestrial and limnological research projects.

- 1976 - 1977. Cornell University, Ithaca, New York.

  Position: Senior Research Associate and Visiting Lecturer in the Section of Ecology and Systematics.

  Responsibilities: Teaching graduate seminar in limnology (Biological Sciences 665); senior-level course in limnology (Biological Sciences 462 with G. Likens); and supervising a limnology laboratory course (Biological Sciences 463). Conducted limnological research at the Hubbard Brook Experimental Forest, N. H., relating to acidification of streams.

- 1973 - 1976. Norwegian Institute for Water Research, Oslo, Norway.

  Position: Research Scientist. Hydrobiology Group Leader for the project "Acid Precipitation - Effects on Forests and Fish."

Responsibilities: Preparation of research proposals and annual budget; supervision of laboratory and field research; coordination of projects within the Hydrobiology Group of the acid rain project (including five research scientists and several technicians); coordination between this group and research scientists in other institutions; and construction and maintenance of a cooperative research station at Tovdal, Norway.

Languages: English, French, Norwegian (reading ability in Swedish and Danish).

Other Relevant Experiences:

- Extensive field experience in limnology, primarily in remote and mountainous terrains of Washington's Cascade Mountains, Sørlandet in Norway, and the Adirondack Mountains of New York State.
- Participated in the conception and execution of the Norwegian Synoptic lake surveys, 155 lakes sampled in two weeks (1974-1975).
- Established and operated the Tovdal Experimental Research Site, Tovdal, Norway (1974-1976).
- Established and supervised operation of the Adirondack Lakes Project Laboratory at Raquette Lake, N.Y. (1978-current).
- Consultant to Environmental Criteria Assessment Office, EPA. Reviewing the Sulfur Oxide and Particulates Criteria Document (1979-current).
- National Atmospheric Deposition Program (NADP). This panel is organizing several precipitation monitoring networks in the U.S. (and affiliated Canadian networks) into an integrated North American monitoring network (1979-current).
- Biological Effects Governing Board of NADP. This panel established by cooperative agreement with EPA will direct all EPA terrestrial and aquatic effects research including on-going work at the National Laboratories to be funded by EPA after FY80, dealing with acidic precipitation, and hopes to act as an integrator of related research in DOA and DOI (1979-current).
- International Joint Commission Research Advisory Board, Committee on Geochemical and Environmental Aspects. The IJC, established by a U.S.-Canada treaty, identifies and mediates disputes concerning boundary waters. I presented the RAB annual report to IJC at Detroit, July 1979 (1979-current).

Presentations, conferences, seminars, and workshops:

FWPCA Technical Seminar: Nutrient Removal and Advanced Waste Treatment. Portland, Oregon, February, 1969.

Eutrophication, Biostimulation Assessment Workshop. Berkeley, California, June, 1969.

Nutrient assimilation kinetics of natural phytoplankton communities. ASLO Annual Meeting, Salt Lake City, Utah, June, 1973.

University of Wales Institute of Science and Technology - Biological Survey of Rivers Workshop. Cardiff, Wales, January, 1974.

Symposium on the Use of Computer Techniques and Automation for Water Resources Systems. Department of State, Washington, D.C., March - April, 1974. (Delegate of the Norwegian government)

Acid precipitation in Norway: Effects on aquatic fauna. First Specialty Symposium on Atmospheric Contributions to the Chemistry of Lake Waters. Longford Mill, Ontario, Canada, September, 1975 (Session Leader).

Acid precipitation problems in Norway. Special seminar, Canada Center for Inland Waters, Burlington, Ontario, October, 1975 (Invited lecturer).

Hydrobiological field studies at the Tovdal Research Station (with H. Leivestad and I. Muniz). International Conference on the Effects of Acid Precipitation, Telemark, Norway, June, 1976.

Effects of pH on periphyton in artificial stream channels. ASLO Annual Meeting, Savannah, Georgia, June, 1976.

Effects of low pH on the early life stages of *Lepidurus arcticus* and mature *Gammarus lacustris* (with R. Borgstrom). ASLO Annual Meeting, Savannah, Georgia, June, 1976.

Results of my biological research work in Norway were also presented to special seminars at the University of Washington, Seattle, and the Massachusetts Institute of Technology in October, 1975, in three seminars at Cornell University, Ithaca, autumn, 1976. Other seminars were presented at the University of Florida, the University of Virginia and Brookhaven National Laboratory in 1977.

ERDA - Office of Environmental Policy Workshop: Quantifying Environmental Impacts from Energy Related Activities. Aspen, Colorado, September 1977 (Invited participant).

Battelle, Pacific Northwest Laboratory Symposium: Developmental Toxicology of Energy Related Pollutants. Richland, Washington, October 1977.

Oak Ridge National Laboratory--Workshop on Sulfur Biogeochemistry. Oak Ridge, Tennessee, February 1978. (Moderator for the Aquatic Effects and Cycling Session.)

The Assembly of the State of New York--Public Meeting on Acid Precipitation. Lake Placid, New York, May 1978. (Chairman of the Subcommittee on Ecology.)

Central Electricity Research Laboratory (U.K.) and Electric Power Research Institute (California)--Ecological Consequences of Acid Deposition. Galloway, Scotland. (Invited participant.)

Environmental Protection Agency and Department of Energy--International Workshop on Limnological Aspects of Acid Precipitation, Sagamore Lake, New York. (Organizer, Chairman of Biological Processes Section, report editor.)

Ecosystem Effects of Lake Acidification. Sigma Xi Lecture, Manhattan College, March 1979. (Invited lecturer.)

Acid Raindrops Keep Falling On My Head. BNL Lecture Series, June 1979.

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Chairman **Ambro**. Dr. Hendrey, I would like to thank you for your most excellent presentation. I would like to say that this subcommittee is extremely concerned about the impacts of acid rain. We have, I suppose, been instrumental in motivating both EPA and the congressional consciousness with respect to these problems.

Canada has recently helped us with that motivation by complaining bitterly about the deposition of acid rain on their forests and estuaries, ponds, vegetation, trees, and things of that nature.

You say a couple of things I would like to ask you about.

I think the thrust of what you were saying is that the research data that we have available to us is both insignificant and small so that we must do much better in terms of our understanding and knowledge of the acid rain problem. Is that a correct characterization?

Dr. **Hendrey**. Mr. Ambro, I wouldn't say it is small relative to our needs, but it is not insignificant. After all, we have a pretty good understanding of the amount of precipitation and its acidity.

It is not a sufficient base on which to make good regulation.

Chairman **Ambro**. Let me see if I understand what this means. You say:

> Currently, regulatory decisions concerning emissions of atmospheric pollutants to control acid rain must be made without the benefit of knowledge as to whether or not crops and forests are seriously impacted by acid rain; whether or not experimental evidence of injury can be used to calculate actual agronomic and forestry losses; whether or not reductions of emissions from several regional sources will produce a desired level of abatement of acid conditions in the surface waters of a receptor region; or even whether or not the effects of soil acidification are reversible within the span of a human generation or on a scale of geologic time.

It seems to me that the point in all of this, and one that we were attempting to raise with EPA yesterday, was that their perforce will be regulations written in anticipation of coal conversion requirements in the absence of data that will permit the regulation writers to write or promulgate those kinds of regulations which, indeed, are based on something credible. Is that accurate?

Dr. **Hendrey**. With respect to ecosystems, that is correct.

Mr. **Ambro**. Where is it not correct?

Dr. **Hendrey**. I think there is a rather large body of data and a reasonable amount of interpretation concerning the emissions of effluents and the budgeting of those materials in the air within the continental United States and, to some degree, within Canada.

It seems quite clear that the acidity of rain is due to strong mineral acids—nitric acid and sulfuric acid—and that the primary sources of these materials are associated with the combustion of fossil fuels.

Now I suspect that a reasonable effort in interpreting this data would allow us to minimize—would allow us to regulate—the formation of acids in the air, but to interpret, for example, how much abatement has to occur to allow lakes in the Adirondacks or streams in the Blue Ridge to be de-acidified, that is, to come back to a natural state, is not there. We don't have that kind of data, so we have to regulate blindly. We regulate only on the basis of pH in the rain and not on the basis of economic loss or environmental or aesthetic loss.

Mr. **Ambro**. With that in mind, and I think that's a most significant response, I would like to read to you a line in your testimony, and read something else, and ask you to comment on it. You say: "if there is to be a multimillion dollar program of research on acid deposition, then diversify its management." Are you familiar with the letter written by L. S. Cowling, who is Associate Dean for Research and Chairman of the National Atmospheric Deposition Program, to Senators Moynihan, Muskie, and members of this subcommittee and committee?

Dr. HENDREY. Yes, sir, I am.

Chairman AMBRO. Let me read for the record something that he said:

> You have proposed that the Environmental Protection Agency should provide leadership for a task force which shall develop a comprehensive program and provide periodic reports of progress and receive and administer the funds necessary to get the job done. The concept of a single lead agency has much to recommend, but the track record of achievements in this role by the Environmental Protection Agency has left many scientists in all the agencies listed above—

And he runs through them—it is too long to mention—but I think you are familiar with the across-the-board funding in acid rain research in the Federal Government—

> with the considered judgment that other forms of leadership will be much more effective in dealing with this particular issue at this time.

In terms of the first statement of yours that I read, can you give us the benefit of your wisdom and tell us how diversifying the management of this program relates to the enforcement or regulatory function and, specifically, your attitudes about the Cowling statement which, in other words, I suppose, says that EPA should not be the agency—the lead agency—or the sole agency to do this, which of course impacts on our view of their budget.

Dr. HENDREY. Yes, sir. Regulatory activity should be based on logic and reason. We should strive to achieve the most effective use of our resources, whether it is atmospheric or dilution, fish in the lakes, or dollars pumped into one kind of activity or another. We want to balance those things in an efficient way.

Currently, we do not have that kind of data. I think that, if you centralize all of your information gathering to one institution, you are likely to endanger the ability to get that data.

I think that, if you have an agency like EPA, whom I must describe more from reputation than actual personal experience, although I have had some of that, is an agency that hastily changes its programmatic directions, that that kind of environment is nonconducive to long-term research.

On the other hand, if you look at the weather data collection system, an activity that has gone on for—what?—100 years or more in this country—there is a widely dispersed network of monitoring stations where the goal is data acquisition itself for long periods of time.

That kind of agency ought to be one that could handle these long-term monitoring type projects. Now when I say monitoring, to some scientists that is a bit of a dirty word. They view just the collection of data for the sake of having data to be not worthwhile.

We currently try to define acid-rain status from data in which no pH measurements were made.

Chairman AMBRO. This is the second bell. We have about 9 minutes to vote on a motion to table a motion to instruct the conferees. In any event, it is a compulsory kind of thing. It is most significant because it deals with the windfall profit tax. We have to leave now and vote. We will come back after we vote.

What I am getting at is if you can see that EPA probably will be the lead agency in promulgating the regulations. I would like you to think about whether or not your recommendation and that of others is realistic in terms of the ability of EPA to utilize diversified data, collected by a variety of agencies or another agency, in buttressing the kinds of realism that is necessary in the promulgations of those regulations.

We will come back and let you reflect on that.

[Recess taken.]

Chairman AMBRO. Dr. Hendrey, we will resume. Do you remember the general thrust of the last question?

Dr. HENDREY. No, sir.

Chairman AMBRO. It had to do with the recommendation of diversity, for example, and the realism of that recommendation given the fact that we might anticipate the regulations which might be used to control acid rain or emissions that lead to it would be in the jurisdiction of the Environmental Protection Agency? How would they therefore bring together data arrived at from a variety of sources and use it in a meaningful way in their own agency? Do you think that is a problem?

Dr. HENDREY. Let me attack the question by responding to the latter part of it first.

As I indicated in my presentation, the collation of data and the analysis of what that data means is a short-term type of program. You can take data on precipitation chemistry, emission inventories, receptor areas, and what we have currently available on response mechanisms, and put together your best interpretation of what it means. That, in a sense, is what goes on all the time. That is what EPA tries to do with available data.

Now to the extent to which that data is available is a very important question. The data should be published, it should be open, and the agency—whether it is EPA or any other agency—ought to have access to it.

To my thinking, it is not very important which agency has responsibility for that kind of activity.

Chairman AMBRO. Well, how in your opinion should acid rain research be organized on the Federal level?

Dr. HENDREY. First of all, as I indicated, it should not be too strongly centralized into one agency because the agencies have different points of view and different track records.

There currently is a proposed interagency coordinating committee. In fact, I think, it may absolutely be established and they have had a meeting or two. That type of committee is capable of representing the interests of various agencies that might be involved in the direct funding of research.

That coordinating committee in a sense would establish line responsibility throughout each of the agencies and a program manager would be assigned to each agency. I can't imagine how it could be done otherwise. You have to have some kind of line responsibility.

However, the program managers do not necessarily form a directorate or dictate what type of research should be done. That activity should be reserved for specialists in the field. Scientists and other persons—technical people—and, to some extent, political people enter into that kind of directive, in terms of establishing the goals of the projects—the overall goals.

Specific research goals should be handled exclusively by specialists—the technical specialists. This could be organized in a variety of ways, ranging from individual grants so that the money is fragmented over the university system——

Chairman **Ambro**. If you will just stop there, we will talk about the organization and money matters in a minute.

Let's say we diversified. Let's talk about trying to bring all the data together. Would you set up a troika or would you have a lead agency. Let's just take one. All of these agencies are involved in this—Fish and Wildlife, Forest Service, Department of Agriculture, USGS, NOAA, DOE—let's just stop and say NOAA, for example. Would you make NOAA a lead agency?

Dr. **Hendrey**. Yes; I would say that——

Chairman **Ambro**. Isn't that fortuitous that I picked that.

Dr. **Hendrey** [continuing]. Making NOAA a lead agency—a fortuitous choice or question, perhaps—would have these benefits. NOAA currently collects large volumes of data, and they know how to manipulate it.

I imagine NOAA would be very good at producing analyses of these quantities of data, insofar as they pertain to the atmosphere. They have essentially no expertise or very little expertise in agricultural matters or in matters of forest or aquatic ecology. You should pick agencies that do have expertise in those areas.

That need not necessarily be reserved; for example, agricultural need not necessarily be reserved to the Department of Agriculture, although it seems like a fit of some sort.

We do not have an agency, aside from EPA, that is responsible for aquatic ecology. We do not have one responsible solely for forest ecology.

In a sense, you will have to look for strong research groups to lead that type of activity.

Chairman **Ambro**. Well, maybe now we can get to how you would structure the management of research programs as opposed to research funding.

Dr. **Hendrey**. Well, in a sense, that is what I was alluding to before. You have to establish some sort of chain of command—some line of responsibility—whose name appears on the document of responsibility.

As I began to indicate, the interagency council is one step in which activities are coordinated. Farther down the chain, you have to interact with the individual scientists. At some point in between, you have to centralize the management program.

I would recommend that you pick those institutions which have a track record of being able to centralize and sublet or, shall I say, subcontract various aspects of research. You might put that into a large university that has a good history of subcontracting or into a national laboratory which has a good history of subcontracting and of managing large complicated projects.

Chairman **Ambro**. As I understand it, the EPA budget incorporates about $6 million for the acid rain research program. I don't know if you are prepared to answer a question like this, but setting up the management structure that you suggest might be done through the pressure of money; but, in your view, is the retention of the $6 million for the acid rain program in the EPA a direct way to proceed or should we move a large portion of that funding and spread it out, or should we leave that level of funding there and add money to other agencies which would interact with the EPA and, by virtue of the increased funding, assure that, let's say, NOAA would be the lead agency. How would you work that?

Dr. **Hendrey**. $6 million in each of the agencies would be very nice—$6 million, if we are restricting ourselves to that figure because that seems to be the one that is receiving some attention, ought to be distributed among several agencies. NOAA ought to receive a share of that. I happen to be involved in that, but I am not an expert in this particular area of the problem, but it seems to me that NOAA would be a good agency to handle the atmospheric portions of it, including deposition monitoring.

EPA, because there does not seem to be another agency doing this type of activity, might be considered for the short-term studies of effects on crops.

Long-term studies of effects on crops, forests, and, perhaps, on aquatic ecosystems—although you are asking for a quick response to the question—might be vested into the Department of Agriculture.

There is, however, the problem that the Department of Agriculture has a reputation of being rather staunchy. Much of the funding that was made available to it under the $15 million grant for the basic sciences did not seem to be distributed in the way it was intended; that is to bring new blood into the agricultural research field. One might be leery of that kind of experience happening again.

Chairman **Ambro**. I have to go vote. My dear friend and colleague Mr. Brown from California, the former chairman of this subcommittee, will chair these hearings and continue the questioning. He is as well a respected and senior member of the Agriculture Committee, so I am sure he would be interested in that. I will be right back.

Mr. Brown?

Mr. **Brown**. Thank you, Mr. Ambro.

Dr. Hendrey, I don't know what was covered in my absence. Do I understand we are talking about a $6 million figure for basically the six-point research program that you have listed in your presentation?

Dr. **Hendrey**. Sir, the six points I listed in my presentation simply identified the types of questions that need different management approaches. This is not a compendium of topics that ought to be investigated, but only illustrates the types of topics, particularly, the time span needed to carry out those kinds of researches.

Mr. **Brown**. How did the $6 million figure come up; do you know?

Dr. **Hendrey**. It was first mentioned in this room by the chairman, Mr. Ambro.

Mr. **Brown**. You refer to the National Atmospheric Deposition Program. That does not have a separate budget at the present time?

Dr. **Hendrey**. The NADP program, as I understand it, is organized primarily by the Department of Agriculture. It is an attempt to set up a large-scale atmospheric chemistry monitoring network. It is attempting to coordinate among a variety of agencies and in a variety of existing monitoring systems to bring together their long-range goals—to bring together a single, large network.

Mr. **Brown**. It does not go beyond the monitoring aspects of the program?

Dr. **Hendrey**. Well, sometimes it is difficult to distinguish what is monitoring and what is, let's say, research. If you look at the deposition of chemistry—its pattern and its temporal change—you can get clues as to what is going on back in the atmosphere. You can calculate deposition rates of materials from the atmosphere.

So, yes, it does have a broader nature than simply measuring the amount and the chemistry of the rain.

Mr. **Brown**. Within the list of topics that you have suggested, I see one glaring omission, and that is long-term health effects. Is that something that is implied under some of the other portions?

Dr. **Hendrey**. Sir, I provided references in table 1 of my report to four research reports, all of which recommend various types of activities which would include health research. I footnoted a new report which will be available within the month, which is being prepared for the interagency coordinating committee, on page 4. That report will list specific projects which should be carried out.

I simply reiterate that my purpose in putting that list forward in that table was simply to illustrate the types of temporal research needs.

Mr. **Brown**. This committee has been concerned for a long time with the problems involved in doing just what you are suggesting here in setting up a fairly comprehensive monitoring research program, in fact, extending it beyond just the question of acid precipitation.

The question I would inquire or that I would ask of you is whether or not this would not fit into an even broader frame work of monitoring and research which might produce additional benefits and help to carry the burden of the cost and spread it over a larger range of objectives? Has that aspect of it been given any thought?

Dr. **Hendrey**. Well, I alluded to that in my report by saying that there are many aspects. I suspect, in the future, we will discover problems that are not currently visible. That is the nature of the acid rainfall. Somebody did not set out to discover the acid rain problem. It cropped up through ongoing monitoring and measurement of atmospheric chemistry of fisheries, especially. We simply discovered it because it appeared in the data, not because we went out looking for it.

I suspect the same thing will apply to other kinds of problems that we are not currently aware of. It might be parasitism on trees.

We have gone through a number of exercises racking our brains, trying to figure out why it is that the forests of the Northeast look so shabby? Why do they lose their leaves early? Why does there seem to be so much dead wood?

I certainly am not going to ascribe that now to acid rain, but the thought crossed my mind.

Mr. **Brown**. There is a fairly substantial body of research on the ecological effects of various forms of air pollution, including the research on the effects on pine forests in southern California and maybe other areas. Research going back 25 years on the effects of air pollution on various row crops and that has been done both in New England and southern California. Most of these have been done by university research organizations, maybe agricultural research departments, but on a somewhat ad hoc basis. It has not been under the systematic regional or national research program with long-range objectives of the type you are listing here.

As I see in various areas a range of different kinds of monitoring for different kinds of things, the thought that comes into my mind is can we build these into a structure in which we can share the cost and spread the benefits?

Dr. HENDREY. Well, sir, I think to some extent that is occurring. The President requested that the various agencies reprogram funding into acid rain research. Often reprograming, becomes retitling because a program might be going on, for example, to measure nitrogen for soils, for a number of years because of basic scientific interests in that topic.

Now we know the role of nitrogen fixing bacteria of nitrifiers and denitrifiers.

It is not wholly inappropriate that those ongoing tasks have been included into the general topic of acid precipitation research. I think that is a mechanism for doing what you suggested, to bring a variety of current problems under a single focus.

Mr. BROWN. Has there been any thought given to research on the beneficial effects of acid rain?

Dr. HENDREY. Yes; there has. There have been several articles about that. Our laboratory has seen some evidence which at first glance looked like a beneficial effect.

J. C. Nogle reported on the effects of sulfur on crops and on forests in the Tennessee Valley area. At the meeting at Gatlinburg, he said, before the host assembled, that he was widely misquoted and his data misused in the articles appearing in some magazines and elsewhere regarding the beneficial or positive effects of fertilizing the world with sulfur through the atmosphere.

In my own laboratory, in laboratory experiments, in the greenhouse, we saw at first what appeared to be a stimulatory effect of sulfur added through the rain on to crops—soybeans, specifically. When we transferred that program out of the laboratory into the field, using standard agronomic practices, large statistically valid numbers in a randomized latin square design, we found there was not any stimulatory effect. In fact, we found a linear, or a linear dose response function over the pH range of 4 to 2.7 with decreases in soybean yield of 3 to 6 percent in the pH range of 4 to 3.2.

So it is very difficult to grab one little item of information, and trying to say aha, there is a beneficial effect. It also illustrates the difficulty of extrapolating laboratory data to field situations.

Mr. BROWN. Have you given any thought to the question of designing the data collection and analysis system in connection with a large-scale research program of this sort?

Dr. HENDREY. Yes; I have. I am a member of the Biological Effects Governing Board of the National Atmospheric Deposition Program, which is organized at North Carolina State University, under a cooperative agreement with the Environmental Protection Agency.

My role in that is to act as an advisor for ecological research. My particular field of expertise is aquatic biology. I am currently in the midst of organizing a large-scale research project in the Adirondack

Mountains. This project is primarily funded, at this time, by Electric Power Research Institute. Funding is also obtained from the Office of Water Resources Technology, and it involves coinvestigators from several universities and three different Federal administrations.

In that project we are examining everything from the deposition of rain to the discharge of aluminum in the outflow stream of the entire watershed. It is a complicated project, and we have given a great deal of thought on how to organize those kinds of data gathering projects.

It has occurred to me that a way not to do it is to centralize it under some kind of single bureaucratic administrator—giving him a great deal of authority in a sense to dictate what the program is going to be, because that person will have a preconceived notion of what one is going to find and will, in a sense, coerce the scientists or the investigators into that type of direction. If investigator A isn't interested in taking that direction, he will run around and find investigator B that is.

Mr. Brown. But it is not a necessary connection between a centralized management and a decentralized data collection analysis program?

Dr. Hendry. No; there is not, as I said earlier, diversity in setting up a program.

Mr. Brown. Even a program with diverse management that you are recommending achieved its maximum utility within a framework that was agreed upon.

Dr. Hendrey. Yes; that's correct.

Mr. Brown. The same thing would be true of the data collection analysis system. You can have either centralized or decentralized management in the entire program and centralized or decentralized not in data collection and analysis, but it would still all have to be within an agreed upon common framework so that one management scheme wasn't collecting data which was incompatible with similar data we had collected from some other source.

Dr. Hendrey. Yes.

Mr. Brown. It is that aspect of it that I was wondering if any thought had been given to it because we are reaching an almost explosive position in data collection within the Federal Government. Unless we begin to rationalize these data collection and analysis systems in some form, we may be inundated with data and not quite know what to do with it.

Dr. Hendrey. Of course, the Interagency Acid Rain Committee—I don't think that is quite the correct title—but the committee that has been established as coordinator among the various agencies attempts to do that. Below that agency, there are groups like the NADP and the Biological Effects Governing Board which brings together essentially all the people that are active in that field of research. We, in fact, discuss at length the compatibility of our methods and our data.

Mr. Brown. Are you familiar with the legislative framework that was set up for the National Climate Research Program?

Dr. Hendrey. No, sir, I am not.

Mr. Brown. Essentially, what we are groping with, I think, in the committee are ways to improve the structure of large-scale research programs and that is one, I would say, experimental structure which has not proven to be completely useful, but it does provide for not a lead agency so much as a single climate research office and then a more or less decentralized network of activities involving other departments and agencies because there are a number that are involved in long-range climate research, particularly, from the standpoint of potential impacts of climate changes, which is a similar problem of what we are dealing with here, it seems to me.

I was hoping the chairman would return; but, since he has not, Dr. Hendrey, I think we should proceed with the additional witnesses.

I want to thank you for your testimony.

Dr. **Hendrey**. Thank you.

Mr. **Brown**. As Chairman Ambro said, it is excellent. You seem to be extremely well qualified in this particular area. How did you get to work in Norway for so long?

Dr. **Hendrey**. I like the snow. [Laughter.]

Is that a serious question? I would be happy to respond.

Mr. **Brown**. That is an interesting aspect to your background.

Dr. **Hendrey**. I finished my doctoral work on alpine lakes in the State of Washington and was interested in being abroad again. I was in the Peace Corps and enjoyed living abroad. I got a $4,000 a year offer from the Research Institute at Tohnon in France. I was not interested in doing another stint in the Peace Corps.

I happened to hear about this acid rain project. I wrote them a letter suggesting how they might carry out some work, and they invited me.

Mr. **Brown**. Thank you very much, Dr. Hendrey.

Dr. **Hendrey**. You're welcome.

Mr. **Brown**. Our next witness will be Dr. Jay Lehr, who is the executive director of National Water Well Association. He will tell us something about groundwater and what research needs to be done in support of protection and restoration of groundwater.

We are most interested in hearing Dr. Lehr's views on this subject, and we want to thank you for coming.

Dr. Lehr, I just noticed and you probably have, too, that the State of Arizona is practically in a state of emergency in regard to groundwater supplies and are about to embark on the massive program to see if they can do something about it. I think that is fairly indicative of the seriousness of this problem and, probably, will spread to other parts of the country. In fact, it has spread to other parts of the country.

STATEMENT OF DR. JAY LEHR

Dr. **Lehr**. It is, and I will touch on the Arizona situation. I wasn't going to, but it is indicative of a major set of problems.

I am Dr. Jay Lehr, executive director of National Water Well Association. We are essentially a nonprofit research institute, with a staff of about 80 people, primarily involved in federally sponsored research projects in groundwater, as well as geothermal energy. We also run an education foundation and a publishing company in water resources and research literature.

We are probably the oldest organization involved in groundwater privately in the United States—going back some 35 years. I've been executive director of the association for 14 years, having previously and presently hold the position of full professor at Ohio State University, as well, in geohydrology.

You have my written testimony, and I will just summarize it, but I thought I might open with the comment I made at the end, which is a quote from a very colorful director of the Groundwater Branch of the U.S. Geological Survey, who passed away a few years ago.

He had said that in 1979—he was really premature in saying it:

> Of all the things that might be said about groundwater in today's world, one that seems highly appropriate to me is an expression of amazement. After years—in fact, decades—in which students of groundwater felt they were just voices crying in the wilderness, the world has suddenly discovered our subject. Now we don't know whether to laugh or cry, because the world suddenly wants from us more than we have to give—more knowledge than was ever demanded before and more than we ever dreamed would be needed.

I am celebrating my 27th year as a practicing groundwater geologist. I started with the U.S. Geological Survey. I spent the first 20 of those 27 years, everytime I met someone, explaining what it was I did because people did not understand what groundwater was. Finally, I would almost say that we are almost in "vogue" in terms, as a resource that everyone has discovered and now recognize it needs protection.

The history of groundwater, congressionally, goes back some 32 years when the Water Pollution Control Act of 1948 was established. Groundwater was mentioned in the act four different times for need for study and protection. Nothing was ever done in that act. The act was amended in 1965 and again groundwater never did receive attention.

In 1972, it received attention in a very negative way. In the 2 years preceding the Water Pollution Control Act, amended passage in 1972, there was a lot of debate about what should be controlled in the act. Everytime groundwater came up, it was brushed aside, primarily, by the oil industry who did not want groundwater regulated because they are involved in the underground in developing oil, and they put back the brine that comes up with oil and gas. They were concerned about being regulated.

Actually, they do an excellent job and that's one area that probably needs no regulation, although they are under a lot of attack from EPA.

It was in the early seventies that finally the drinking water people recognized that we were only protecting water for fish, and not really water at the tap, and a coalition of groups interested in tap water got together and pushed for what became the Safe Drinking Water Act of 1974.

I testified 12 different times between 1969 and 1974, prior to the passage of the act, trying to get them to recognize that the groundwater was not protected in the Water Pollution Control Act and, therefore, it should be protected in the Safe Drinking Water Act because half of the water we drink is groundwater. Finally, we did get a section on underground injection control in that act, and that led to some awareness in 1974.

It was the Resource Conversation Recovery Act which closed all the loopholes that were not closed in the Safe Drinking Water Act, and then the Toxic Substance Control Act, and then finally the Surface Mining Control Act, which gives us all the legislation we will ever need to control every bit of groundwater that exists in the United

States. That amount of groundwater is about 30 times as much water as is available to us in rivers and streams and all surface water sources.

The legislation, however, is not doing what needs to be done. It will take many years to pass the regulations for protecting groundwater that need to be passed, and that is fine, and that will all be done in due course. Probably, the slower we go the more knowledgeable and better our regulations will be.

What is being totally ignored is the tremendous need for research in the groundwater area. As Dr. McGuinness said before his death, there is just so much we do not know and more than we ever dreamed of supplying. No really major effort has been approached yet to solve the problems that we have in groundwater.

Interestingly, there has been a major laboratory within the EPA system that would be set up to attack groundwater problems, but it is out in Ada, Okla.; it has an excellent group of people. It is small—a fine facility—but it is just kind of out of the millstream. Any time some program at EPA needed men or money, they went out and pillaged the laboratory at Ada—stole their positions and stole their money. It is still going on. This year's budget for that laboratory was $1½ million, initially. During the course of the year, I believe, they've already taken away about half a million dollars that was needed in other areas.

So all the money and all the people, for the most part, within the water resource program, has gone into surface water; it's gone into municipal waste treatment projects; it's gone into water supply treatment programs. It has not gone into groundwater research.

Half the water the Nation drinks is groundwater. About 24 percent of the water the Nation uses is groundwater. There is an incredible amount of groundwater yet undeveloped, but we are seeing more and more pollution problems.

Mr. Ambro, your own district in Long Island—I know you know that many of the wells have been closed down because they are finding toxics, organic solvents, in the groundwater. Everybody is familiar with the situation at Love Canal, the Valley of the Drums, and things like that. We are going to be seeing more and more of that, not occurring from new sources, but just popping up from old sources that we are only finding out about. It is very, very scary.

There is a need for a tremendous amount of research, much of which was already outlined in previous legislation, but it has never been carried forth because it just hadn't carried the clout within EPA. There is no lobby. There is no big voice for groundwater interests. I have to say, almost apologetically, the National Water Well Association, though it has 8,000 members in among water well drillers and groundwater geologists, we do no lobbying; we do no legislative work. It is mostly water well drillers or family-owned businesses or geologists. They are kind of private or relatively quiet people, and they do not pay enough dues really to support any lobbying program.

NWWA 10 years ago moved away from being a dues-collecting organization and became a science research center. Eight percent of our income is dues, and the rest of it is research, education, and publishing. We are kind of proud of that. We look at all the problems objectively.

The point is there is no lobby; there is no loud voice who has ever pushed and said we need groundwater research and so it always lost out. When you divide up the pie at EPA, groundwater always was at the bottom and still is. The wherewithal, I think, is within EPA to begin focusing more attention and more money on the problem.

In my testimony, I have offered nine areas or things that need to be addressed. Some of them you might not think are research. I've addressed training first, information and technology transfer second, and technical assistance third. Well, you say, that's not research.

A good researcher who wants to investigate any problem first does a literature search and finds out all that is necessary to know—everything that has been done before so that we don't reinvent the wheel.

First of all, we have a community of Federal and State regulatory people with very little background in groundwater hydrology that needs to be brought up to speed as to what information is available already before they really determine what more needs to be done. EPA should take the lead in that training program. They once did. They no longer do.

There has to be a machinery in place to insure that whatever research EPA does is distributed.

I heard Mr. Brown talk about all the data that is being collected on various programs, and the problem is we may be deluged with data and don't know what to do with it.

That is true with research across the board. We do the research; we write a report; and put it up on the shelf and we don't distribute it.

Before EPA goes forward with many esoteric research programs, they have to be sure they have the ability to put that research plate out where it is needed through publications, through workshops, and they also need to establish a working relationship with the State and local governments that they can assist them in obtaining the information that they need.

I put those three areas along with research.

Then the next six rather obvious areas are learning about the sources of groundwater pollution. We pretty well delineated what they are. I am not sure we know the severity of all of them.

We need a great deal of work on the methods of detecting pollution—monitoring wells—and various types of logging and geophysical methods.

We need better laboratory procedures for finding out what is in the water.

We need more studies on what happens to pollutants in the ground, how are they transported, what is the ultimate fate of the pollutant, when does it show up, and how long is it going to last?

A new area that we have a desperate need for, that nothing has ever been done about, is categorizing the nature of the underground as to the way it will handle a pollutant that gets into the ground. For instance, we have mapped the United States in soil profiles. We know the nature of the soil everywhere in the United States and how that soil reacts to the growth of plants. We need to map the underground, not just the geologic formation, but to understand the regime of certain areas and how it will react when pollutants get into the ground.

Finally, we need to figure some ways to clean up some of the aquifers that have already been polluted.

There are the nine areas that I think need to be done. We need a line item somewhere in the budget to protect groundwater in the sense from having to divide up the pie with all the other heavier interests in

EPA to see that the program really gets off the ground in a more organized way.

I might say that we have seen tremendous trained changeover with the people within EPA in the past 10 years, from a group of administrators who cared little at all about groundwater, or, let's say, they gave into pressures from other directions.

There is a great deal going on within EPA, from the standpoint of trying to gather the troops together in a mounted effort, but I don't think they have the direction yet or the funds to do it.

That ends my summary of my prepared statement.

[The full prepared statement of Jay H. Lehr, Ph. D., executive director of National Water Well Association, Worthington, Ohio, is as follows:]

ON THE NEED FOR A GREATLY EXPANDED EPA GROUND WATER RESEARCH PROGRAM

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As recently as ten years ago ground water was practically unknown and totally misunderstood. Even six years ago it was still ignored, slighted and undervalued. Only in the last ten years has it achieved status as a major resource and only then when it was found subjected to incredibly thoughtless pollution. Finally today ground water is finding its way to the head of the line as the latest "in", "vogue" or faddish resource to protect.

Such has been the scenario of public recognition and reaction, and it has been emulated with equal ignorance by the state and federal agencies who can lay claim to potential jurisdiction over it. The Congress and the Environmental Protection Agency which it spawned must be labeled co-conspirators in the snubbing of ground water as a significant resource a decade ago.

The story must begin in 1948 when the first Water Pollution Control Act was passed into U.S. law. Despite apparent disinterest in ground water through much of the 70's, some 32 years ago, the initial water pollution control legislation implied, inferred or directly sited the need for ground water protection in no less than four sections.

The thinking of Congress regarding ground water continued on a positive note through 1970 when the National Environmental Policy Act was passed requiring the preparation of Environmental Impact Statements for projects which might have a significant adverse effect on surface or ground water quality or quantity. But when it came to taking specific pollution control action the tables turned dramatically.

During the debate which was waged for two years subsequent to the passage of the Water Pollution Control Act Amendments of 1972, efforts to focus attention on ground water protection were turned aside with blatant disdain. The ultimate passage of PL 92-500 left us with a truly misnamed law. It should have carried the appelation Surface Water Pollution Control Act as mention of ground water occurred only seven times in its pages. Little as that attention was, EPA which inherited the jurisdiction over the act managed to respond to the newly ammended law as though ground water were not mentioned at all. While a significant amount of research could have been performed under the act's provisions, little was. One of the few research documents developed with the support of this legislation titled "A Manual of Model Laws Regulations and Institutions for the Control of Ground Water Pollution" was printed in minimal quantity and then stored in a dark room away from the light of public attention. Such an attitude was the product of EPA's Research Director, Stanley Greenfield who in the early 70's scheduled hundreds of people and billions of dollars for an attack on surface water pollution while showing no interest in a resource the public could not literally see.

This myopic attitude was carried on by his successor Wilson Talley who accepted the responsibility of carrying out the directives mandated in the Safe Drinking Water Act of 1974 and the Resource Conservation and Recovery Act of 1976. The SDWA began to fill the void in ground water protection left by the Water Pollution Control Act of 1972 after which RCRA truly plugged the hole in our pollution control dike. But the early years following the passage of the Safe Drinking Water Act saw no action. The SDWA though light on regulation was heavy on attention to research specifically requesting that studies be made relating to

1. disposal of waste, including residential which may endanger ground water,
2. methods of underground injection which will not degrade ground water,
3. methods of preventing, detecting and dealing with surface spills of contaminants which may degrade ground water,
4. the nature and extent of the impact of abandoned injection and extraction wells on ground water
5. the nature and extent of the impact of intensive application of pesticides and fertilizers on ground water,
6. the nature and extent of the impact of ponds, lagoons and pits or other methods of surface disposal of contaminants on ground water.

Yet, with all this new found focus on ground water, EPA managed to look the other way and even attempt to dismantle what little ground water research had been going on before.

Between 1974 and 1977, EPA's only research laboratory with any history and directive to perform studies relating to the protection of the nation's ground water was stripped of most of its personnel component and saw its budget drastically reduced as the ground water science community looked on incredulously.

Finally in the closing years of the last decade, EPA's head of the Office of Drinking Water, Victor Kimm recognized the dangers of overlooking the protection of the source of one half of our nation's drinking water. Kimm began to refocus his department's emphasis giving equal time to ground water but was handicapped until Stephen Gage moved in as the head of EPA's Office of Research and Development and showed an enthusiastic willingness to support Kimm's recognition of the need to protect ground water.

With continued delays in the development of adequate underground injection control regulations, funds earmarked for state assistance for program implementation went unspent. Kimm argued successfully for permission to use the nearly five million dollars in unused funds to undertake a Surface Impoundment Assessment in all 50 states. This study gave EPA much needed data pertinent to the drafting of necessary regulations. Concurrently this assessment initiated a basic ground water education program among state environmental agencies.

Simultaneously Myrna Hurd took over as the Director of EPA's 208 Program and made it clear to all the nation's areawide waste water management programs that ground water protection must be a concurrent objective in all their plans.

Stephen Gage himself, through his position as EPA's Research Director, has initiated three major efforts aimed at closing the gap in emphasis between surface and ground water protection. In 1978, Gage announced that the Robert S. Kerr Water Resource Research Laboratory in Ada, Oklahoma, would become the center of a five-year plan to expand the national research effort in ground water protection. That same year Gage established a National Ground Water Information Center at the National Water Well Association Research Facility in Columbus, Ohio and in 1979 he established an extra-mural National Ground Water Research Center jointly between Oklahoma, Oklahoma State and Rice Universities.

During the past two years, effort has been put forth to define, develop and implement a ground water research strategy, but progress has been stymied by the lack of direction and funding from Congress. Other issues of a water pollution control program including water supply and waste treatment plant technology at the municipal level completely dominates the budget picture leaving ground water programs and research with only the crumbs. The constituency behind the aforementioned programs are too powerful to be dealt a setback in funding which could occur were greater emphasis to be placed on ground water.

Thus, it is imperative for the Congress to specifically direct its attention to the need for strengthening the nation's ground water protection program overseen by EPA.

Such a mandated program should build on the strength and facilities of the existing EPA laboratory at Ada, Oklahoma which can house twice the compliment of personnel presently employed there and would be capable of directing a research program.easily five times its present size, including both intramural programs and extramural project coordination.

An expanded EPA Research Program aimed at Ground Water Protection should address nine major areas which include

1. training,
2. information and technology transfer,
3. technical assistance,
4. sources of ground water pollution,
5. methods of detection,
6. analytical procedures,
7. transport and fate of pollutants,
8. subsurface categorization,
9. aquifer rehabilitation.

1. Training - How can EPA be expected to protect the nation's ground water when there are not enough trained hydrogeologists in the entire U.S. to handle the job. There are less than 500 adequately trained hydrogeologists in pertinent federal and state environmental agencies while there is a need for ten times that many. It will likely take most of this decade to supply the required professionals who will range from lab technicians to chemistry, virology, geology and hydrology experts. The task is a difficult and complex one which must be initiated immediately. The Robert S. Kerr Water Resource Research Center was once a major training center in this field and must once again regain that stature.

2. Information and Technology Transfer - must be implemented through the establishment of publications and workshop programs at all significant levels of public awareness. Information and technology must be disseminated in a timely manner to all audiences capable of utilizing it for the protection of our ground water. Research developments must not be allowed to gather dust on bookshelves as is now so often the case.

3. Technical Assistance - programs must be designed to assist state and local agencies to implement comprehensive ground water protection plans. Too many local groups are forced to reinvent the wheel without an adequate system for obtaining basic assistance from qualified sources.

4. Sources of Ground Water Pollution - must be studied to ascertain their severity in the overall ground water pollution problem growing throughout the nation. Work needs to be performed to determine ways to minimize the potential impact of pollution from each source. Twenty-one separate ground water pollution sources were delineated by the National Water Well Association report entitled "Manual of Model Laws Regulations and Institutions for the Control of Ground Water Pollution," written for EPA in 1975, they include

1. landfills, dumps, and excavations,
2. holding ponds and lagoons,
3. water and waste water sludges and effluents,
4. waste piles and stockpiles,
5. animal feedlots,
6. fertilizers,
7. pesticides,
8. surface water infiltration,
9. septic tanks,
10. storage and transmission facilities,
11. accidental spills,
12. highway salting,
13. air pollution,
14. drainage wells and sumps,
15. artificial recharge,
16. disposal wells,
17. water supply wells,
18. exploration holes and abandoned wells,
19. oil and gas - recovery,
20. mining,
21. ground water development.

5. Methods of Detection - which require study include among others remote sensing, ground water tracers, logging techniques and monitoring wells.

6. Analytical Procedures - in the laboratory to ascertain the presence of pollutants are still in need of refinement.

7. Transport and Fate of Pollutants - in saturated and unsaturated porous media continue to pose many unanswered questions which must be addressed with great intensity. Sorption processes of the soil in regard to trace metals and organic solvents are yet unknown in many instances.

8. Subsurface Categorization - of aquifers and soil profiles as to their capacity to attenuate, eliminate or pass pollutants requires considerable attention.

9. Aquifer Rehabilitation - is the last resort in a pollution control program. No matter how successful future protection is, there will be many more incidents such as Love Canal, Valley of the Drums and organic solvent disposal in Long Island, where an ounce of prevention is too late. The application of some yet undetermined cure is the only option if the area is ever again to yield a potable water supply.

The need for a greatly expanded ground water research program can not be overemphasized. If we could shut off the twenty-one sources of ground water pollution tomorrow, we would still have the sword of Damocles hanging over us, for we know not the extent of the pollution which has gone on before. Only through the initiation of the programs described above can we properly attack the problems we face.

In summary, let me quote the former chief of the Ground Water Branch of the U.S. Geological Survey, C. L. McGuinness who said in an address to the Midwest Ground Water Conference in 1969, "Of all the things that might be said about ground water in today's world, one that seems highly appropriate to me is an expression of amazement. After years--in fact, decades--in which students of ground water felt that we were just voices crying in the wilderness, the world has suddenly discovered our subject. Now we don't know whether to laugh or cry, because the world suddenly wants from us more than we have to give--more knowledge than was ever demanded before, and more than we ever dreamed would be needed."

Chairman **Ambro**. Dr. Lehr, I must compliment you on your excellent testimony.

I might say, too, that your views are eloquently extemporaneous and nearer to those of many of us. That which you outline in your paper is most thoughtful.

I might say, too, that this subcommittee is probably the major lobby in this Government for groundwater research programs. We are not, however, always very effective in having the appropriations process include the kinds of moneys that we included in the authorization process for groundwater research program.

I would say as an aside, too, that maybe your lobby and our lobby is the elevation of the problem to consumers, who live in those areas, such as Long Island, with a number of well closings, as a result of intrusion of our industrial organics, which resulted, I might say, in minor programs of controlled technology in the form of aeration and carbon filtration up in Glen Cove.

I agree completely with everything you say. I really can't take issue with very much, except that earlier on you did say that RCRA closed all the loopholes. Is that the phrase you used?

Dr. **Lehr**. Yes, exactly.

Chairman **Ambro**. And that we have the authority that we need. Now, RCRA deals with wastes. What about nonwaste pollution—process leaks, storage tank leaks, pesticides, acid rain leachate, which is what we heard about before. Do you think it closes all the loopholes with respect to that?

Dr. **Lehr**. No. It doesn't, but I do believe that, within our air pollution legislation, theoretically we can. Acid rain is a problem and air pollution can cause groundwater pollution.

I feel the air pollution laws are strong enough, if they are properly managed, to do that job. I think that surface water laws are strong enough to stop pollution in our streams and infiltrate groundwater.

RCRA closed—true—the waste loopholes that were left. I think the Toxic Substance Control Act can be used to see that toxic chemicals are not transported through pipelines that, ultimately, leak into the ground and cannot be removed.

I do think from a regulatory standpoint we have enough laws, though the regulations are not written yet, and it is going to take years to get them all into place. I am not too much in favor of haste there because I think we need a lot more answers and a lot of analysis to be sure we write good regulations. But I do feel that RCRA closes the waste loophole.

Chairman **Ambro**. Two more fast questions. You mentioned the mapping of underground water and aquifers—things of that nature. What is the extent, in your opinion, from your experience of the job that has been done by USGS in this regard?

Dr. **Lehr**. The U.S. Geological Survey, historically, was the only organization that really knew what groundwater was. I think, however, that in USGS the family of scientists have become very shy—really, closeted scientists. They got so tired of telling people what groundwater was that they stopped doing it, and they just kept to themselves—a very closed society.

The data they developed—the work they did in cataloging the Nation's groundwaters—has been excellent. About the only argument one can make against the USGS is that they are so concerned about saying anything wrong that they take too many years in reviewing and rewriting to be sure they are right; and, by the time they come out with their publications, it's obsolete and its use is not what it could have been a couple years earlier.

I think their work has been excellent, but they have not done much work in the pollution area. Their research has been mostly in the mapping area. A great deal more needs to be done. There is a big difference in the kind of mapping they do and what I am suggesting. What they have done is catalog the existing aquifers in the United States and are more and more quantifying the amount of water we have.

When I use the statement that we had 30 times more groundwater than we have surface water, it is being verified every day. The new reports say we have five times more groundwater in a certain area—in the Northwest, for instance, recently, than they ever anticipated they had. They are not looking at aquifers. They are not looking at the underground from the standpoint of its receptivity to pollutants.

What I am suggesting is that we begin looking at hydrogeologic maps that indicate a sensitivity to various activities than can pollute the ground. You can look at the topography; you can look at the climate; you can look at the soil; and you can look at the subsurface strata. Develop a classification that integrates all these things and tells you—you better not put an industry there that has a waste-disposal problem that might be difficult to handle because, if it gets into the ground there, it is really going to get away from you; it is going to pollute a lot of groundwaters. You might say this is a highly sensitive area. You wouldn't want to do certain activities because of potential ground pollution.

Other areas you would say because of the nature of the aquifers and the climate and so on, you would have little problem. An example would be Arizona being so arid that everybody wants to dump their wastes there because there is so little rainfall that none of it will get washed into the groundwater. It will all get held up in the tight caliches and clays in the surface and never get washed down below. Of course, the people in Arizona don't like the idea at all.

I failed in my opening statement to mention Mr. Brown's referral to a situation in Arizona, and that is an area of research that I have not mentioned in my testimony.

The Arizona problems are management problems. Their need is not for the kinds of answers that I have listed in my testimony. Their problem is due to the fact that they are a groundwater dependent State that has totally ignored any effort to manage their resources—manage their surface and groundwater in any conjunctive way, to get numbers to regulate its use. There are a number of States like this—Kansas and Nebraska—which are overirrigating at this time—parts of California.

There is an area of research and groundwater different from what I have listed that goes into managing a resource—conservation, integrating the surface and groundwater use. It is an area really that also needs attention. Although a good deal of work has been done in writing papers, very little attention has been paid to it by the various States to do the job.

Chairman AMBRO. You know, I couldn't agree with you more. I think, though, that what you touch on conjures up problems of such monumental proportions that it is almost unfathomable to solve or to address.

For example, that kind of interdisciplinary approach you suggest would involve those municipalities which have the power to draw on; therefore, the power to plan; therefore, the power to lay out the kinds of uses for land that would impact adversely or beneficially on those aquifers. Then you get involved in that morass of local decisionmaking that is almost impossible to break through.

We tried it on a small scale on Long Island. It was rejected 10 years ago when we proposed it by something called the Planning Commission out there. It is still rejected because they look at it superficially in terms of little colored charts on maps where commercial, industrial, residential zones should go, but never weave into their thinking the effects of what they do on just one element—groundwater, for example. It is hard to get them to understand those interrelationships.

The last question in terms of your rather ambitious groundwater research effort: How much do you think it would cost, if you are prepared to answer that, and how long would it take?

Dr. LEHR. I think I have given a good deal of thought to that. I would say, using the budget that was assigned to the Ada Laboratory last year, which never ended up getting there—the $1½ million which was way too small—I would recommend a doubling of that amount initially to about $3 million, and then a staging up to $5 million within over a 3-year period. Then holding it at about the $5 million level. I think we are talking about a decade of groundwater effort. I think it is going to take 10 years to really catch up and find all the answers.

That may sound like a long time to some people—environmentalists that are kind of impetuous getting all the answers, getting all the regulations in place. It does not seem terribly long to me. As I said, I have been in this field 27 years, and the first 20 nobody knew what the heck it was they did.

I am more than happy to spend 10 more years finding out the answers. I do not think $3, $4, and $5 million groundwater budgets within EPA are large at all in comparison with the literally billions that are spent on municipal waste treatment in various surface water programs; but, at the same time, I don't favor the spending of more money than they can adequately manage. I think it is always a mistake when you all of a sudden throw more money at people than they are prepared for, and then you get a lot of waste and inefficiency.

I think it should be on a gradual staging, but it has to be done in some way that it is really protected.

Chairman AMBRO. But that response suggests that you would continue to use Ada as the primary facility for groundwater research. Is there any other approach that you would suggest with respect to what we have now?

Dr. LEHR. A lot of effort has gone into looking at a super Federal agency in groundwater—something I have always opposed. I think if one can solve the problem with the existing machinery, you are way ahead from a cost standpoint; you are way ahead of reducing the bureaucracy. When Senator Kerr established the laboratory—it was named after him because he was the one that fought for the money and, literally, put it in his backyard—it was established as the groundwater research branch. That was over a decade ago.

They have a fine facility. It is in a nucleus of very good people. They have been trying to do a job for the past 10 years. It would seem very frustrating now that the world has discovered groundwater to give the job to someone else. I think they should, finally, at last, be given the resources to show what they could do.

I also favor the centering of research out in the middle of nowhere, rather than right on the beaten track where people can interfere. I think that is why they have never been able to fight very well for their men and money, however, because, you know, it is those people out in Ada—they don't matter.

Chairman **Ambro.** Senator Kerr is not here any more.

Dr. **Lehr.** That is right.

Chairman **Ambro.** Mr. Walker?

Mr. **Walker.** Thank you, Mr. Chairman.

I am impressed with the detailed program that you outlined for research. Could you give us some idea as to how EPA's present research program meshes with what you are proposing here.

Dr. **Lehr.** They are doing no training. They are doing no technology transfer to speak of. They have a small technology transfer section which is not, frankly, accomplishing much. They have their technical assistance program.

They are doing work right now in studying the sources of groundwater pollution—a minimal amount. They are doing work on methods of detection, analytical procedures, and transport and fate. So items, 4, 5, 6, and 7 are being attacked with very limited resources, but I would say the initial results of some of the studies they have funded, extramurally—places such as Stanford Research Institute, as well as work going on at Ada—indicate that they are on the right track and they know what they are doing.

They are doing absolutely nothing in terms of subsurface categorization of groundwater bodies and nothing in aquifer rehabilitation. There is some private work going on in that latter area, but nothing to my knowledge that has been funded by EPA.

Mr. **Walker.** Would you agree with the sense of priorities there that the areas they are acting in are the areas which demand the greatest priority and the areas they are not acting in are things which might more properly be left behind?

Dr. **Lehr.** Yes; I would. I think, with their limited budget and their in-house expertise, they have used the money wisely and attacked those four areas.

They were once a training center for groundwater and were totally stripped of that capacity. They would very much like to get back at it. They are very aware that their reports get very little distribution because they have no budget for it. They get dumped into the NCIS and that is the end of it.

But I think, the answer to your question is, yes, they have done the best they could with what they had.

Mr. **Walker.** Thank you very much.

Thank you, Mr. Chairman.

Chairman Ambro. Thank you, Mr. Walker.

Mr. Brown?

Mr. Brown. Dr. Lehr, in the air pollution control legislation, we have something called prevention of significant deterioration in air quality. Is there any comparable authority in the groundwater area?

Dr. Lehr. They are working that out now. In the UIC regulations, one of the things they have to do is determine some sort of standard for the pollution or nonpollution of groundwater. Not only do they say you can't pollute the water, you can't make it any worse than it already is, or are you going to say you can't make it worse than a certain standard that we are artificially going to set. That will be a part of the UIC regulations when they are finally promulgated. That has not been concluded, but it is addressed in the legislation and is required to be treated.

Mr. Brown. When this subject originally came to the attention of this committee, Chairman Ambro was the only one who had much knowledge of it because of the problems in his local communities in Long Island. Within the last year, there have been several thousand contaminated wells in California which had to be closed.

My question is do you have knowledge or is it possible to get information as to how widespread this phenomenon of contaminated wells, closed wells, is?

Dr. Lehr. It is very widespread; that is to say that studies, not statistical studies, but let's say the anecdotal collection of data on a national basis, which was undertaken some years ago by EPA, and the program was stopped because of the lack of funds. They were doing areawide pollution studies just to look at an area and say how it appears to be.

The indication is that pollution is widespread but not volumetrically. In other words, we find many, many instances, and they cross the country east and west and north and south, but the amount of water that is contaminated is relatively small. We are still at a stage where one can spend an ounce of prevention and save the pound of cure.

It is rather scary though because we are finding pollution from sources that existed decades ago. We are going to find many more of these, but there is nothing we can do about that. We are in a position, I think, to stop the continued source of contribution, and we are going to have to deal with what is already there. In some of the areas, we are going to have to cleanse the water.

We can head off development, perhaps, in some areas where pollution will occur, because of sources that earlier existed and we know more about what happens to the contaminants. We could also prevent scares—unnecessary crises—by knowing more about how the pollutant is going to act or die.

I recall a situation in Gray, Maine, where they were worried about wells being polluted. People had the idea that if one well was polluted it would spread through the ground-waterway—a surface contaminant would spread. You dump a contaminant in the middle of a river and it spreads across the banks. Groundwater does not act that way. The people at Gray, Maine, felt that if one well was polluted, for miles around the wells were. While it was a fairly narrow stream of pollution, one could track it and know where it was going, but people up there did not know that and there was a big scare about it.

The more we know about how the ground carries pollutants and how they tend to die out, how they tend to be absorbed on the soil particles in some areas and not on others, will help us to determine what the future holds for the pollution that has already been caused.

Mr. Brown. I am thinking in terms of building up a greater sensitivity to the importance of this problem amongst the members of Congress. Two years ago, we would not have taken an interest in the problem we thought was just Long Island's. Today, in California, you would find a great deal of support of action to prevent the kinds of things that are happening up there.

Dr. Lehr. All 50 States are touched by it. Groundwater pollution is occuring everywhere, and we are going to rely more on groundwater in the future by far than we have in the past. We are at a crossroad where, if we start acting now, we can stem the tide and, at least within 10 years, I think we can reach a status quo where we are no longer fearful of what is going to come. There is no question the problem is absolutely everywhere.

Mr. Brown. I would like to just make one final comment about the Arizona water situation. This is a peculiar and complex combination of water quality and water quantity problems that are overdrawn on both groundwater and surface water, and a combination of groundwater and surface water problems. The basic problem is they have overdrawn for irrigation. They pledged to return irrigation flows to highly saline soils, and it comes back percolated through the ground into the river or wherever as highly polluted. In some cases, it was several thousand parts per million of dissolved salts.

To give you an indication of how much money we are spending, the Congress has voted what I think is going to cost them a $1½ billion for one plant to take some of the salt on one irrigation district.

Dr. Lehr. Yes. The Arizona one is very complex. I was thrown out of Arizona. I used to teach at the university, and I became a persona non grata because I spoke very strongly against the Arizona project. You didn't last very long at the university; I was a heretic actually.

They have thrown more money at the problem than I think need be. Again, it is a management problem. The irrigation has caused the pollution, and continued irrigation is now causing more pollution and they are not going to solve that problem.

Let me bring out one other point of what is a strong fear of mine. As we see more and more groundwater pollution—and we are not approaching it in an orderly manner from a research standpoint—people will get scared and they will stop using groundwater, which will be very unfortunate. Also, if they become overly fearful of pollution, they will not take advantage of other uses of the groundwater. I speak there specifically of the fact that it will surprise you to hear me say that, 10 years from now groundwater will be a more important source of energy for us than it is currently as a source of drinking water.

The use of shallow groundwater for geothermal energies from water-source heat pumps will become a primary use of this resource. Extracting the water, taking heat out of it, and returning the water a little cooler or a little warmer, depending on whether you are cooling or heating with it, right back to the ground is going to be one of the most exciting alternate systems for rural, suburban housing.

In some States that are seeing groundwater pollution now, they are getting very afraid of taking the water back in. They say, Oh, you are going to pollute it.

Groundwater—geothermal heat pump—is a closed cycle. You take the water out in a closed tube, you extract heat from it, and you put the water back in a little cooler; or, in the summer, you take it out, you reject heat to it, and put it back a little warmer. The Earth's heat, the Sun's heat, both work to keep the groundwater temperature constant. It returns to its normal temperature within a few feet of the well.

This has been a very exciting potential for this unknown and undervalued resource, but we are seeing a dozen or more States that will not allow the use of the water this way. They will allow the use of the water, but they won't allow the water to be returned to the ground. Well, you'd afford to consume that amount of water when you don't need to. You want to put it right back into the ground. They are saying, Oh, we are not going to allow any returned water into the ground because it might pollute.

Another reason for getting all our information out on the table—so that people will understand the nature of the resource, is how it can be polluted and, in fact, how it is not polluted.

Mr. **Brown**. I have no further questions.

Chairman **Ambro**. Thank you, Mr. Brown.

Mr. Ritter?

Mr. **Ritter**. Yes. I am impressed by the kind of testimony you have given because you seem to have a realistic appraisal of the problem you've been working with.

I would like to go into these ideas of scares and crises. I like the way you would like to avoid them. I guess what you are saying is a little education is part of that once of prevention.

I am just curious as to—in the States across the country, when these things happen, are you saying that there are just not groundwater specialists available to monitor these wells or contaminants that are found in wells, or there is nobody there to comment on it and the press picks it up and runs with it. Is that what you are saying?

Dr. **Lehr**. Exactly. There are not enough trained hydro-geologists either in the private sector, and God knows not in the governmental sector, to deal intelligently with the problem. That is exactly what happened. The press picks it up. Either there is not an expert available to speak intelligently to the press or the press does not know where to find one. You said it all.

Mr. **Ritter**. Let me ask you. What are some of the effects of these organic chemicals in the well water? We know that TCE is a carcinogen. We also know that aflatoxin is the carcinogen in peanut butter. I happen to eat a great deal of peanut butter.

What are the amounts of TCE that you need to adversely affect human health and, when they discover these contaminants in well waters—I know we can detect parts per million and parts per billion, and now in parts per trillion—what exactly are we finding when we find this in terms of health effect, or do we even know? Can you comment on that?

Dr. **Lehr**. Yes. I think a lot of our so-called groundwater pollution problems and putting things in proper perspective is the fact that we can now measure things in water that we could never measure before, and that many of the things have been in the water for decades and not caused a health problem.

Mr. Ritter. With G. C. mass spectroscopy you could all of a sudden discover things that you couldn't discover for 2,000 years prior.

Dr. Lehr. I don't think we have so many new things in water because we have already found some things that are already in the water. I think we tend to go overboard and create scares and we find some part per billion in some esoteric chemical. Where the National Institutes of Health has clearly found that something is carcinogenic at some level and drunk for a certain period of time, then we have a poor drinking water source, but I think there is a tendency to close down sources that are probably perfectly OK even though they have a part per billion of some particular chemical.

Mr. Ritter. Is there any effort on the part of people like yourself, and regulators, and people who are dealing with these contaminants, to put some idea of relative amount and danger of relative amount as opposed to simply identifying a skull and crossbones on a part per billion?

Dr. Lehr. The National Academy of Sciences is working under contract from EPA on a certain list of chemicals that have been mentioned in the Safe Drinking Water Act, for example, and I believe also some from Research Conservation Recovery Act, and the National Institutes of Health is, also, working on a variety of these chemicals.

The results of many are yet to prove anything. A few are clearly in controvertible.

I do believe there is an adequate amount of research going on in those areas. In fact, that is the sort of thing that attracts the most attention quickly and can get the dollars.

Mr. Ritter. So there is the research going on to tell us not only of the existence of these things, but how dangerous they are in relative amounts?

Dr. Lehr. From a health standpoint, I would say the health effects research is going on very well. How they exist in groundwater, their transport and fate characteristics, less so; that is to say that, if you found it in one place in the aquifer, how fast might it move and what would be the nature of it.

Mr. Ritter. So the mere existence of what we perceive is dangerous chemicals is not in and of itself enough to close things down or create large scares?

Dr. Lehr. It should not be. I don't think it should be, but it can be. That is the way people react. We are doing a survey now—EPA is—of rural water supplies. They are testing water randomly around the country, looking at some of the things that are in the water. I think they will probably find a few surprises that people have been drinking for 20, 30, or 40 years and are perfectly healthy. It is going to be a problem putting those results out.

Mr. Ritter. Yes; that is one of my concerns with the detection that we have. Unless we have some better feel for what the relative amounts mean to people who are consuming these contaminants, we could shut off a lot of groundwater.

Dr. Lehr. We could do that. It is not impossible for that to occur. Ten years from now, the easiest solution might be to put a small reverse osmosis unit for $300 on your kitchen's sink and get 8 or 10 gallons of perfectly pure water every day and not worry about all the junk that is in either your surface water or your groundwater. I mean, it might be a cheaper way to solve the problem. It is possible.

Mr. RITTER. One last thing. You list 21 sources of groundwater injection, or whatever. Are there any priority areas where you feel, like, a half dozen of these—there are so many of them and they really cover a large spectrum—is there any place that, say, those of us in this committee should be particularly concerned?

Dr. LEHR. The worst by far are pits, ponds, and lagoons. Municipal and industrial storage pits, and waste piles are more of a solid waste problem where we don't know what is going on.

I mentioned in my comments that EPA has addressed this. They used some money that they were unable to use for some other programs to begin assessment of these kinds of waste facilities.

I think storage of liquid and solid waste on the ground is probably the worst problem of any of those listed. Highway salting, you know, we are very well aware of it. We are easily capable of solving that. The Government is the one that throws the salt on the road, and we can minimize that. We are able to control well construction so that we do not allow surface pollution to get down around the casing of a well.

All of these areas are very active pollution problems somewhere in the country. Most of them can be controlled fairly easily, and the pollution or waste disposal on the surface is by far our worst problem.

Mr. RITTER. Thank you very much, Dr. Lehr.

Thank you, Chairman Ambro.

Chairman AMBRO. Thank you very much, Mr. Ritter.

Mr. Blanchard?

Mr. BLANCHARD. I have no questions.

Chairman AMBRO. Again, Dr. Lehr. I would like to thank you for being so patient, and so comprehensive, and so thoughtful, and so excellent in your responses. I appreciate it.

Dr. LEHR. Thank you.

Chairman AMBRO. I would like to now turn to our friend from Michigan, Mr. Blanchard, for the introduction of the next witness.

Mr. BLANCHARD. Thank you, Mr. Chairman. If I were to give the appropriate introduction, we would be here a lot longer than all of us wish to, and I am sure not only does Dr. Vostal have a schedule to meet, but our witness after that, Dr. Cox, has a schedule as well.

Let me just simply point out for the record that, in Dr. Vostal's testimony, he has outlined his very distinguished credentials. He happens to work in the 18th Congressional District in Michigan, something near and dear to my heart. He is here as the head of the Biomedical Science Department of General Motors Research Laboratories. He is going to talk about the health effects of diesel emissions, something we probably are going to hear more and more about.

Without any further ado, before we lose everyone, I better stop right now and welcome you, Dr. Vostal, and we look forward to your testimony.

STATEMENT OF DR. JAROSLAV VOSTAL

Dr. VOSTAL. Thank you very much, Mr. Blanchard. We certainly appreciate very much the possibility to be here. We certainly appreciate when we can find our representatives from Michigan discussing such an important issue.

As you can see my background is mainly in medicine. In my present role at General Motors. I am responsible for a research laboratory with more than 70 professionals and technical members which are involved in crash injury and environmental toxicology research.

At the outset, I would like to emphasize that the General Motors Corp. does not have any intention of increasing diesel engine use on the highways if the public health would be endangered from diesel particulate emissions.

General Motors had previously studied all available health effects data on diesel emissions and concluded that there was not a significant risk to the human health.

If it is discovered in the future that diesel particulates pose a significant risk to public health with the wider use of diesel light-duty motor vehicles, then General Motors Corp. will revise its future planning for such use. If such a decision is required, it could be made prior to the time when enough diesels would be on the road to endanger public health.

My testimony has been submitted in writing and is available, and I am trying to emphasize only some of the highlights in my brief introduction.

The significance of the higher particulate emissions in consideration of the possible risk to health is mainly because the particles are of the size that can easily penetrate into the deep region of the respiratory system.

As it may be expected, there were different views on this subject presented by the Environmental Protection Agency and by the automotive industry.

The rationale behind the extensive studies commenced by both EPA and by the automotive industry has differed sharply as the initial evaluation of the program.

The objectives of our research in the GM Research Laboratories are outlined on the side and assume that first, mutagenicity tests alone cannot serve as a basis for the health effects assessment; second, experimental models must be based in field relevant conditions; and third, long-term human exposure studies are the most significant factor in risk assessment.

The Environmental Protection Agency, on the other hand, has put most of its emphasis on the short-term laboratory tests, and has concentrated its in-house and extramural efforts mainly on the "nature and biological activity of diesel exhaust to form a more complete data base for future assessment of the potential cancer risk." Because of this approach, this means to be based mainly on the short-term laboratory tests. The Agency faces great difficulty in extrapolating the data from simplified laboratory conditions to the unbelievably complex mammalian and human cells.

We do not basically disagree with EPA's findings on the mutagenicity of some samples of diesel particulate extracts by organic solvents, but we seriously question, as have many other people, their meaningfulness for predicting the long-term public health effects.

We strongly believe that the final evidence must be documented by an inhalation model where the route of entry of diesel particulates in the respiratory system is reasonably identical with the type of exposure expected in the real life.

A second major question is whether it is scientifically appropriate to use an organic solvent to extract the hydrocarbons absorbed on the core of the diesel particles. The strength of an individual solvent like dichloromethane to solubilize such organic matter is many times stronger than anything found in the human body and, therefore, it cannot simulate the mechanisms by which the biologically active compounds can be released in the organism for the interaction with the sensitive cells of the respiratory system.

Using identical methods as EPA, we have demonstrated that, when fluids have been used which are compatible with the internal environment of the human body, the mutagenic activity was significantly reduced and represented only a small fraction of mutagenic effect reported for the organic solvent.

As you can see from the figure when we compare the mutagenic effect of dichloromethane extracts with that obtained by incubation of diesel particulates with body simulating fluids, like serum, blood proteins solutions, or saline, we can never observe the same kind of activity as is obtained by strong organic solvent extraction.

Similar differences in the rationale behind the experimental assessment of the potential risks can be observed between EPA studies and research initiated by General Motors in the long-term animal inhalation experiment.

Since EPA research programs test animals for a limited exposure period only and use but one maximum tolerable concentration of the diluted diesel exhaust in the animal inhalation experiments, we feel that meaningful information cannot be obtained through this procedure. Unless several exposure levels are used and the exposure contract is prolonged to permit an accumulation of a significant amount of particles in the lung, we will not be able to determine the real significant dose-effect relationships for the risk assessment.

Our approach was to use a long-term animal inhalation model, exposing hundreds of small laboratory animals to various levels of diluted diesel exhaust for 20 hours per day for up to 18 months in the GM Research Laboratories large volume exposure chambers.

When we look at the next figure which is comparing the estimate of the maximum expected concentrations in the lungs of experimental animals after 1 year of exposure it indicates that, even for the lowest experimental concentration of 250 micrograms per cubic meter, the exposure of the experimental animals has been at least 1,000 times greater than that which can be expected for population groups continuously exposed on our roads in the year 2000. The human exposure estimate is based on the best estimate of model studies and predictions of the regional annual mean concentrations for larger American cities, as it was reported by William and Chock in the meeting which was held by EPA at Cincinnati, in December 1979.

In coordination with the academic laboratories of Wayne State Medical and the University of Arizona School of Medicine, all exposed animals have been extensively studied for evidence of tumor incidence and other harmful effects on the respiratory system.

The studies show that, in spite of the fact that the accumulated particulates in the lung exceeded expected dosage in humans by a factor higher than 1,000 pulmonary functions remained unchanged in the exposed animals and the microscopic studies showed no evidence of lung tumors—even after 1 full year of exposure.

I would like to demonstrate to you briefly a few slides indicating the conditions of the exposure and the results of our studies.

If we look at the animals, you can see from the outside appearance that the animals have been exposed to extremely high concentrations of the diesel particulates.

The animal on the left-hand side has been exposed to concentrations of 6,000 micrograms per cubic meter which 1,000 times exceed the concentrations expected on our roads in the year 2000.

If we look at that effect which occured in the lungs, then we compare it after 10 weeks of exposure. On the right-hand side there is a lung from a controlled animal. On the left-hand side, you can see the lung from an animal exposed to our lowest exposure dosage, which was 250 micrograms per cubic meter.

You can see that, even in this relatively low concentration range and short period of time, we can demonstrate a slight change in the color of the lung tissue.

If you wait for the 34 weeks of exposure and for the highest concentration which we have used—1,500 micrograms—the next slide indicates without any doubt that a large amount of particulates accumulated in the lungs.

How does it look in the microscopic picture? This is a schematic picture of what we can see under the microscope. I would like to bring your attention to the upper left corner where the respiratory airways end, and the most critical part of the respiratory system, called the alveolis, starts. This is where we expect the particulates can be deposited. This is also the area about which we have been most worried.

If you look into a historical picture of a lung in a normal animal, you can see, again, the small compartments, the lung pulmonary alveoli. On the next slide, you will see the lung from the exposed animals and the only difference we can observe is the occurrence of several black dots in the picture. These black dots which you can identify in a large amount represent a special type of cell, so-called pulmonary alveolar macrophage, which is practically stuffed with the diesel particulates.

Those are the cells which have the function to clean the respiratory system from all outside intruders. They are protecting the respiratory system against the possibility of a prolonged contact of the small particulates with the cells.

In addition, we have also been able to show that the respiratory system has an effective mechanism to dispose of the inhaled particles which can protect against most of the adverse effects of the diesel particles. This lung clearance mechanism is schematically indicated on the next slide and compared with the real situation on a historical slide from the exposed animals.

Chairman Ambro. While we appreciate immensely your showing this, this is a bit more than I can consume. If you can summarize it so we can ask you some questions that we have with respect to EPA, and your research, and the budgets, and things like that, I would appreciate it.

Dr. Vostal. I certainly agree with you, Mr. Chairman. This was all I have planned to show from the technical side. Maybe it would be useful if I could be permitted to give you at least some information about the differences between the EPA approach and the differences of the automotive industry.

Chairman Ambro. If you could speed that up, we would appreciate it.

Dr. Vostal. Yes.

Particularly, in the cancer risk assessment strategies of the potential adverse health effects of diesel particulate, the EPA approach has systematically ignored the epidemiological data. Instead of it, the Agency has emphasized comparative extrapolation of epidemiology data from available reports on roofing tar, cigarette condensate and coke oven emission exposures as its method of choice.

There is a committee which has been appointed by the National Academy of Sciences to provide the evaluation of the diesel impact on the community. As part of this evaluation, the committee has reviewed the risk assessment methods of EPA and sharply criticized the EPA's basic assumptions, extrapolation logic and scientific validity of the intended use of coke oven emissions data. Their opinion was presented in a letter which says:

> This committee's Health Effects Panel has concluded that the assumptions forming the basis of Cancer Assessment Group's (of EPA) Initial Review were insufficiently supported by verifiable scientific evidence to permit their application to the effects of diesel engine emissions.

This is my final statement: It is important to note that in this respect, there exists a study on the potential effects of the wide use of diesel engines. This study can be found in Europe, in the city of London, where the diesel buses have been used for more than a quarter of a century.

The study was conducted on garage workers and concluded that, while this is a group exposed to significant concentrations of the diesel emissions and represents an exposed cohort of about 420,000 man-years during the period 1950 to 1974, there is no significant difference in the incidence of the lung cancer between the exposed group and the incidence of the lung cancer in the normal population of the Greater London area in the same age group.

In summary of this point, I would like to emphasize that the statement which has been presented in the first part of this London study in 1957 and said that, on the basis of the figures that were available at that time, there is no need for us to consider that the "diesel exhaust fumes may be a serious contributory factor in producing an excess of lung cancer in urban city dwellers," is equally valid today.

Thank you, Mr. Chairman. This concludes my testimony, and I will be very glad to try to answer all your questions.

[The full prepared statement of Jaroslav J. Vostal, M.D., Ph. D., department head, Biomedical Science Department, General Motors Research Laboratories is as follows:]

Statement of
General Motors Corporation
to the
House Subcommittee on Natural Resources and the Environment
# of the
Committee on Science and Technology

Presented by
Dr. J. J. Vostal
Departmental Head, Biomedical Science Department
General Motors Research Laboratories

Washington, D.C.
February 20, 1980

Good afternoon. I am Dr. Jaro J. Vostal, Head of the Biomedical Science Department of the General Motors Research Laboratories at Warren, Michigan. I have obtained my degree in medicine from Charles University, Prague, Czechoslovakia, in 1951 and my Ph.D. degree in Industrial and Environmental Toxicology in 1961, also in Europe. Prior to joining General Motors in in 1974, I was on the faculty of the University of Rochester School of Medicine, New York, in the Department of Preventative Medicine, Pharmocology and Toxicology. Thus, I have spent the largest portion of 25 years of my professional career on research and teaching environmental science and toxicology.

In my present role at General Motors I am responsible for a research laboratory with more than 70 professional and technical members involved in crash injury and environmental toxicology research. Among other programs, our department has been heavily involved in studying possible health effects from automobile emissions--particularly diesel particulates.

I appreciate the opportunity to report on General Motors views and research efforts.

Statement of General Motors

At the outset, I would like to emphasize that General Motors Corporation does not have any intention of increasing diesel engine use on the highways if the public health would be endangered from diesel particulate emissions.

General Motors had previously studied all available health effects data on diesel emissions and concluded that there was not a significant risk to human health. In fact, after several additional years of study and research by GM and others, we believe the same situation prevails today.

If it is discovered in the future that diesel particulates pose a significant risk to public health with the wider use of diesel light-duty motor vehicles, then General Motors Corporation will revise its future planning for such use. If such a decision is required, it could be made prior to the time when enough diesels would be on the road to endanger public health.

Importance of Diesel Characteristics: More Fuel Economy and Reduced Emissions

Diesel engines play an important part in GM's future plans to meet consumer demands for fuel-efficient personal transportation, as well as the national need for further improvements in fuel economy. The most outstanding advantage of the diesel engine is its demonstrated ability to achieve about 25% improvement in fuel economy compared to that of a gasoline-powered car with similar weight and acceleration performance. However, it also reduces CO emissions, and does not require a catalytic converter.

The main difference is that it produces small microscopic particles of carbon, in an amount which is claimed to be about 30 to 100 times higher than a catalyst-equipped gas-powered car of corresponding performance. The significance of the higher particulate emissions in consideration of the possible risk to health is mainly because the particles are of a size that can easily penetrate into the deep regions of the respiratory system.

If we analyze a diesel particulate carefully, we find that it is formed by an insoluble carbonaceous core and by a variable mass fraction of hydrocarbons attached to the surface. In 1978, General Motors Research Laboratories had already presented data showing that particularly this characteristic of the diesel particulate is highly variable and may be dependent upon several other factors, such as engine size, design of the engine, temperature, fuel quality, etc.

EPA Concerns

On November 4, 1977 the Environmental Protection Agency issued a precautionary notice on laboratory handling of concentrated diesel particulates and extracted organics (1). The notice was based on results obtained by the agency in tests of exhaust samples from two heavy-duty diesel engines examined by the so-called Ames-Salmonella mutagenicity assay. These assays are biological tests using microbial cells in an artificial environment. The tests are normally used to screen chemical compounds for a possible effect on the genetic material in the living cells. A positive result is considered as "suggestive" evidence that the chemical compound may be a cancer-producing agent, i.e., a carcinogen.

Difference in Initial Evaluation of Health Risk

In the EPA approach, the entire amount of hydrocarbons adsorbed on the surface of the carbonaceous core has been stripped away from the core by a powerful organic solvent called dichloromethane. This extract was then used in the laboratory procedure just described to expose a specific strain of bacteria developed for this purpose.

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[1] Gage, S.J., "Precautionary Notice on Laboratory Handling of Exhaust Products from Diesel Engines," Office of Research and Development, U.S. Environmental Protection Agency, Nov. 4, 1977.

The results of these tests were found to be positive in the micro-biological assay tests. Since EPA considers that such a result identified substances that are carcinogenic in whole animal studies, the Agency believes it was necessary to warn the public that diesel exhaust products may constitute a possible risk to public health.

Meanwhile, a search conducted by General Motors of the scientific literature on health effects from diesel particulates revealed that epidemiological studies investigating the incidence of lung tumors in population groups exposed to diesel exhausts had been conducted by the Medical Research Council in Great Britain from 1950 to 1954 (2). The studies, published in 1957, were unable to find any difference between the incidence of lung cancer of workers who had been exposed to diesel exhausts from buses in the London Transport System, and the frequency of the lung cancer in the general population. The report concluded:

> "...all that can be said, on the basis of the small figures so far available, is that there is no excess of lung cancer among any group of London Transport staff such as would have been expected if diesel exhaust fumes were a serious contributory factor in producing an excess of lung cancer in urban dwellers."

As I will indicate later, in 1979 the studies were extended to include workers exposed to diesel exhaust up to the year 1974 with virtually the same conclusion (3).

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[2] Raffle, P.A.B., "The Health of the Worker." Brit. J. Industr. Med., 14, 73, 1957.

[3] Waller, R., "Trends to Lung Cancer Incidence in London in Relation to Diesel Fume Exposure." In: International Symposium on Health Effects of Diesel Engine Emissions, Cincinnati, OH, December 3-5, 1979.

Let me summarize the difference in the initial evaluation by EPA and GM. In 1977 EPA reported that diesel particles were mutagenic in bacterial assays and indicated a potential for higher cancer risk in the U.S. population from diesel emissions in 1985. In sharp contrast, the lack of evidence of any transient or permanent effect based on the negative epidemiological studies of London Transport workers assured General Motors Corporation that growth of a light-duty diesel vehicle population and of diesel particulate concentrations in the atmosphere, predicted to occur by 1985 and 2000 would not, according to the current state of knowledge, threaten any adverse effects on public health.

However, the EPA administration again concluded in January, 1980 (4) that "the uncertainty surrounding the potential risk posed by the diesel particulates warrants a cautionary approach." The discrepancy in health-related claims just described has motivated intensive studies by the EPA and the industry prior to large scale production of light-duty diesel vehicles.

Comparison of Research Approaches

The rationale behind the extensive studies commenced by both EPA and GM Research Laboratories has differed just as sharply as the initial evaluation of the problem. The research objectives of General Motors Research Laboratories, as they were outlined in the beginning of 1978, assumed that:

First, Mutagenicity tests alone cannot serve as a basis for health effects assessments; Second, Experimental models must

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[4] Environmental Protection Agency FRL 1381-4: NO_x Waiver Decision; Decision of the Administration, Federal Register, 45:16, p. 5490, Wednesday, January 23, 1980.

be based on field relevant conditions; and Third, Long-term human exposure studies are the most significant factor in risk assessment.

The Environmental Protection Agency, on the other hand, has put most of its emphasis on the short-term laboratory tests, and has concentrated its in-house and extramural efforts mainly on the "nature and biological activity of diesel exhaust to form a more complete data base for future assessment of the potential cancer risk," and on the "estimates of the risk based on assumptions made for the purpose of analysis"(4). Since the capability of the short-term laboratory assay to predict the level of carcinogenicity of various chemical compounds for human being has been seriously questioned and widely discussed in several international meetings during the last year, we do not intend to lengthen the discussion further. Because of this approach, EPA faces great difficulty in extrapolating the data from simplified laboratory conditions to the unbelievably complex mammalian and human cells.

We do not disagree with EPA's findings on the mutagenicity of some samples of diesel particulate extracts by organic solvents, but we seriously question, as have many others, their meaningfulness for predicting the long-term public health effects.

We strongly believe that the final evidence must be documented by an inhalation model where the route of entry of diesel particles into the respiratory system is reasonably identical with the type of exposure expected in real life.

A second major question is whether it is scientifically appropriate to use an organic solvent to extract the hydrocarbons adsorbed on the core of the diesel particle. The strength of such solvent to solubilize such organic matter is many times stronger than anything found in the human body and, therefore, cannot simulate the mechanisms by which the biologically active compounds can be released in the organism for the interaction with the sensitive cells of the respiratory system. Extensive studies are now investigating this matter in our laboratories and other academic laboratories. The first results of these investigations were presented at the recent International Symposium on Diesel Exhaust Health Effects in December, 1979 (5,6).

Using identical methods as EPA, we have demonstrated that when fluids have been used which are compatible with the internal environment of the human body, to prepare the extract, instead of the strong organic solvent, the mutagenic activity was significantly reduced and represented only a small fraction of mutagenic effect reported for the organic solvent.

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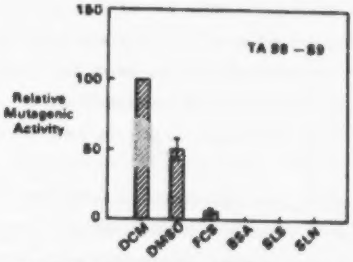
[5] Siak, J., Chan, T. L. and Lee, P., "Diesel Particulate Extracts in Bacterial Test System," in: International Symposium on Health Effects of Diesel Engine Emissions, Cincinnati, OH, December 3-5, 1979.

[6] Rudd, C. J., "Diesel Particulate Extracts in Cultured Mammalian Cells," In: International Symposium on Health Effects of Diesel Engine Emissions, Cincinnati, OH, December 3-5, 1979.

Figure 1 compares the mutagenic activity of dichloromethane (solvent) extract with extracts of the same sample by fetal calf serum, solution of serum albumin and a simulated lung surfactant. It can be seen that the mutagenic activity extracted from diesel particulates by typical body fluids like blood serum (FCS) or solution of blood proteins (BSA) is entirely negligible in comparison with that observed after the use of organic solvent which is not available in the human body.

Figure 1



Comparison of the mutagenic activities of diesel particulate extracts DCM (dichloromethane), DMSO (dimethyl sulfoxide), FCS (fetal calf serum), BSA (0.5% bovine serum albumin), SLS (simulated lung surfactant), and SLN (saline).

From Siak, J., Chan, T.L. and Lee, P., Diesel Particulate Extracts in Bacterial Test System," in International Symposium on Health Effects of Diesel Engine Emissions, Cincinnati, OH, Dec. 3-5, 1979.

The data indicate that while all the findings obtained by using the organic solvent extract from diesel particulates may be of significant scientific value, they are not valid as predictors of potential health effects of diesel particulates inhaled into the human respiratory system. We strongly believe, that unless EPA research considers the availability of the chemical compounds adsorbed on the surface of the diesel particles for the biological fluids in the human body, their estimates on increased risk of lung cancer due to diesel emissions will remain arbitrary and unrealistic.

Unfortunately, the same criticism applies with equal validity to other EPA studies, including those testing the carcinogenicity of diesel exhaust extracts (again, obtained through use of organic solvents) on a sensitive type of laboratory mice(7). In a similar program, initiated by our Research Laboratories, we are using not only the organic solvent extract, but also extracts of biological fluids which are painted on the skin of laboratory mice in a long term experiment.

From a different viewpoint, it is also important to understand that the biological activity of diesel emissions as attested by the mutagenic assay is, according to EPA experts, determined more by the quality of the fuel used, rather than by the combustion process in the diesel engine,

> "...the mutagenicity of the particulate emissions is influenced by the fuel and to a lesser extent by the vehicle"(8).

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[7] Dr. Stephen Nesnow, U.S.E.P.A., Session V. "Mutagenic and Carcinogenic Potency of Extracts of Diesel and Related Environmental Emissions." International Symposium on Health Effects of Diesel Engine Emissions, Cincinnati, OH, December 3-5, 1979.

[8] Huisingh, J., Bradow R. et al, "Application of Bioassay to the Characterization of Diesel Particle Emissions." Environmental Protection Agency Symposium, Williamsburg, VA, May 1978.

At General Motors, we similarly recognize that vehicle fuel is important, not only in predetermining the biological activity of the diesel particulate, but also in reducing the mass of particulate emissions. Recent findings by the GM Engineering Staff have shown up to a 40% reduction in particulate emissions can be obtained by modification of the fuel. Obviously, the oil refining industry needs to be involved in fully evaluating this potentially promising approach.

Whole Animal Tests

Similar differences in the rationale behind the experimental assessment of the potential risks can be observed between the EPA studies and research initiated by General Motors in the long-term animal inhalation experiment. These GM investigations should indicate not only the potential carcinogenicity of the inhaled diesel exhaust, but also should discover whether any other potentially harmful effects exist of diesel emissions on the respiratory system.

Since EPA research programs test animals for a limited exposure period only, and use but one maximum tolerable concentration of the diluted diesel exhaust in the animal inhalation experiments, we feel that meaningful information cannot be obtained through this procedure. Unless several exposure levels are used and the exposure contact is prolonged to permit an accumulation of a significant amount of particles in the lung, we will not be able to determine significant dose-effect relationships for the risk assessment.

In this respect, the research supported by the Department of Energy, which plans to determine the dissociation rate of particle-bound organics in mammalian lungs and provide an integrated health risk assessment, is more appropriate than the EPA approach and is based on correct physiological principles[9].

Our approach was to use a long-term animal inhalation model, exposing hundreds of small laboratory animals to various levels of diluted diesel exhaust for 20 hrs/day for up to 18 months in the GM Research Laboratories large volume exposure chambers.

Results of GM Research

We have had the opportunity to report on the first results of the chronic inhalation studies at a recent international meeting organized by EPA at Cincinnati, in December of 1979[10].

Figure 2 shows a calculated comparative estimate of the maximum expected concentrations in the lungs of experimental animals after one year for different levels of exposure and indicates that even for the lowest experimental concentration of 250 micrograms per cubic meter, (ug/m^3), the exposure on the experimental animal has been at least 1000 times greater than that which can be expected for population groups continuously exposed on our roads in the year 2000. The human exposure estimate is based on the best estimate of the regional annual mean concentration for larger American cities as reported by William and Chock(11) earlier in the Cincinnati meeting (see Figure 3).

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[9] Subcommittee on Natural Resources and the Environment of the House Science and Technology Committee, November 8, 1979.

[10] International Symposium on Health Effects of Diesel Engine Emissions, Cincinnati, OH, December 3-5, 1979.

In coordination with the academic laboratories of Wayne State Medical School and the University of Arizona School of Medicine, all the exposed animals have been extensively studied for evidence of tumor incidence and other harmful effects on the respiratory system. The studies show that, in spite of the fact that the accumulated particulates in the lung exceeded expected dosage in humans by a factor higher than 1000, pulmonary functions remained unchanged in the exposed animals and microscopic studies showed no evidence of lung tumors -- even after one full year of exposure.

In addition, our studies indicated that the respiratory system has an effective mechanism to dispose of the inhaled particles, which can protect it against most of the inhaled particles. The capacity of the lung clearance mechanism, which includes a rapid scavenging of particles by specific cells in the deepest regions of the lung and the ability to transport these cells out of the body by the respiratory airways or into deposits in the lymphatic nodes are large enough to take care of an enormous excess of diesel particles.

Similar accumulation of particles in pigmented lymph nodes routinely is observed in the smoking population and in populations exposed to other forms of dust, without further pathological changes in the lymphatic tissue. We feel, therefore, that this phenomenon should (1) be evaluated as a positive indication of the defense of the organism against the inhaled aerosol and (2) be considered more as a sign

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[11] Williams, R. C. and Chock, D. P., Characterization of Diesel Particulate Exposure, International Symposium on Health Effects of Diesel Engine Emissions, Cincinnati, OH, December 3-5, 1979.

Figure 2

EXPECTED LUNG DOSES OF INHALED DIESEL PARTICLES

Diesel Particle Exposure (μg m⁻³)	Calculated Lung Retention Per Year Assuming 20% Dep (μg)	Resulting Lung Concentration (mg g)
[illegible] 250¹	5,000 μg	5
1,000²	20,000 μg	20
6,000³	80,000 μg	80
[illegible] 5³	5,000	0.005

¹[illegible]

²[illegible]

³[illegible]

From Vostal, J. J., Chan, T. L., Garg, B. D., Lee, P. S., and Strom, K. A., "Lymphatic Transport of Inhaled Diesel Particles in the Lungs of Guinea Pigs Exposed to Diluted Diesel Exhaust," International Symposium on the Health Effects of Diesel Engine Emissions, Cincinnati, OH, December 3-5, 1979.

Figure 3

PROJECTED PARTICULATE CONCENTRATIONS DUE TO LIGHT DUTY DIESELS FOR VARIOUS CITIES IN THE YEAR 2000 (μg m⁻³)*

	Regional Annual Mean	Roadside 24 Hour Maximum
Chicago New York Downtown	3.5	8.8
Cincinnati Denver Philadelphia Downtown	2.0	6.0

*Assuming 1% per year growth rate in total vehicle miles travelled, 25% diesel penetration and 0.2 g/mile particulate emissions.

From Williams, R. L. and Chock, D. P. EPA International Symposium on Health Effects of Diesel Engine Emissions, Cincinnati, Ohio, December 1979.

of excessive exposure, than as evidence of the biological activity of the inhaled diesel particulates[12].

We conclude that, despite massive exposures and excessive accumulation of particles in the lung, no increased risk for tumor formation was confirmed, and no changes in pulmonary function and structure were detected to date. Lung clearance mechanisms were found to effectively remove the deposited particles from the sensitive cells and may be expected to provide significant protection, in addition to mucociliary clearance, against the effects of the inhaled diesel particulates. Both systems have a large capacity to remove inhaled diesel particles from the sensitive cellular structures of the respiratory system and seem to be fully capable of protecting the general population against any potential adverse health effects of diesel emissions, particularly under the conditions of low level exposures expected on our roads with the expanded use of diesel engines. In this respect, our results confirm the findings obtained in the epidemiological studies.

Risk Assessment

Let me return briefly to one of the differences in approach between that used by EPA and that of the GM Research Laboratories.

In the cancer risk strategies, the EPA approach has systematically ignored the epidemiological data from the diesel garages of the London Transport group. Instead, the Agency has emphasized comparative extrapolation of epidemiology data from available reports on roofing tar, cigarette condensate and coke oven emissions exposures as its method of choice.

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[12] Vostal, J. J., Chan, T. L., Garg, B.D., Lee, P.S., Strom, K. A., "Lymphatic Transport of Inhaled Diesel Particles in the Lungs of Guinea Pigs Exposed to Diluted Diesel Exhaust," International Symposium on the Health Effects of Diesel Engine Emissions, Cincinnati, Ohio, December 3-5, 1979.

Based on the testing of comparable samples in the short term laboratory bioassays, the EPA rationale plans to predict the relative potency of the diesel particulates to cause cancer in the real world. If the potency of diesel particulates is found to be smaller or greater in the laboratory tests than the mutagenic effects of the roofing tar, cigarette condensate, etc., then, EPA's Cancer Assessment Group will use the same relative potency for prediction of the expected carcinogenicity risk from diesel emissions.

The recently appointed NAS-NRC Diesel Impacts Study Committee (DISC) reviewed the Agency's concept as part of a systematic evaluation of the risk assessment methods and sharply criticized the EPA's basic assumptions, extrapolation logic and scientific validity in the intended use of the coke oven emissions data. The Committee Chairman wrote on November 26, 1979 in his letter to the Assistant Administrator, Mr. David G. Hawkins(13):

> "This committee's Health Effects Panel has concluded that the assumptions forming the basis of Cancer Assessment Group's (of EPA) Initial Review were insufficiently supported by verifiable scientific evidence to permit their application to the effects of diesel engine emissions."

At the public meeting of EPA in Arlington, December, 1978, we also criticized the EPA approach(14) and emphasized its weaknesses in comparison with the direct epidemiological data available from the London Transport Study.

In this respect, it is important to note that -- as I mentioned previously -- the validity of the British London Transport Study was further confirmed by additional data, presented by

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[13] Letter of the NAS-NRC Diesel Impact Study Committee, Dr. H. Rowen to Mr. David G. Hawkins, Assistant Administrator, EPA, on November 26, 1979.

[14] Discussion Transcript, p. 178, Proceedings of the Scientific Review Meeting on the U.S. Environmental Protection Agency, Diesel Emission Health Effects Research Program.

Dr. Robert Waller from the British Medical Research Council Toxicology Unit, at the Cincinnati meeting in December 1979. He reported there that the original four years exposure observations had been expanded to evaluate a total of more than 420,000 man years of diesel exhaust exposure during the period from 1950 to 1974. The results showed that, in the 25 year period of the study, the number of London Transport Bus male operators aged 45 to 64 years who either (1) died, (2) retired due to ill health, or (3) were transferred to other work because of lung cancer disease, did not significantly differ from the expected lung cancer death rates among the population of the greater London area in the same age group.

In spite of isolated critical comments about several epidemiological qualifiers of the London Transport Study, it is our strong opinion that this study provides the most persuasive information to date that the expanded use of diesel engines on our roads will not increase the risk or frequency of lung cancer in our population.

Third Party Review Function

It would be most helpful in these complex matters involving objective evaluation of scientific data -- their adequacy and meaning -- if a third party review function were available to rule in the public interest. Such a third party review would function independently of either the federal government or the industry. General Motors recommended to EPA that such a function be established early in the period of research on diesel particulate health effects but, unfortunately, although the EPA Administrator agreed initially with this concept, nothing which accomplishes this function has been established.

Significance of Diesel Health Effects Research Reports

As a conclusion, I would like to quote from testimony recently given to a Senate Subcommittee on this subject by Dr. Ancker-Johnson, vice president of Environmental Activities Staff of General Motors, Jan-January 30, 1980, where she stated(16):

"The three categories of evidence which we deem pertinent to this issue are the following:

Animal Inhalation Experiments:

No tumors or other significant adverse health effects have been noted, after an exposure period of approximately 45 weeks despite exposure levels up to several thousand times more than expected ambient levels which humans would breathe.

Short Term Laboratory Tests:

The organic extracts of diesel particulates have been shown, in some cases, to produce adverse biological effects, but these effects vary with the extraction medium employed. No effects have been noted where the extraction medium is one which occurs in the human organism.

Epidemiology Studies:

The only completed epidemiology study is one involving employes who worked on London's diesel buses in the London Transport Garages. This study disclosed no significant increase in lung cancer among the affected group despite a 25 year exposure.

While admittedly such evidence would benefit from further replication, it is helpful to keep in mind that just like many other things we eat or breathe every day, it is impossible to prove, by any finite series of experiments, that diesel particulates produce absolutely no adverse effects upon human health. The most which can be done is to look for such effects, proceeding from the most likely to the least likely places, until we have either found the evidence we sought or have so reduced the probability of its existence as to justify an abandonment of the search.

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(16) Dr. Betsy Ancker-Johnson, Testimony before the U.S. Senate Committee on Government Affairs, Subcommittee on Energy, Nuclear Proliferation and Federal Services, January 30, 1980.

In summary of this point, it can be concluded thus far that no evidence has yet been found which says diesel particulates are a threat to public health. Additionally, it can be said, the existence of such evidence must be adjudged somewhat less probable today after one year of research and some 85 technical papers have been presented during the three-day Cincinnati Symposium, than it was at the beginning of the research effort.

That concludes my testimony. I would be glad to receive your questions. Thank you.

* * * *

Chairman AMBRO. Thank you very much, Dr. Vostal.

Mr. Walker.

Mr. WALKER. Thank you very much.

I think one of the things we are most interested in, from the standpoint of this subcommittee in looking at the budget aspects, is getting some idea as to how much research you have done in comparison to the research done by EPA. Do you have some idea as to what the investment of GM has been in diesel effects research?

Dr. VOSTAL. I certainly am not prepared to give you a final version of what would have been really the funds which have been spent in supporting the research on diesel emissions. We are prepared to provide it to you in writing.

All that I can tell you is that, based on just my estimate of funds which have been spent in the department on salaries, wages, supply materials, and the outside contracts in the year 1979, the diesel research represented the total spending of approximately $7.5 million only in that single year.

Mr. WALKER. That relates to about $6 million in the budget this year that EPA has set aside.

Dr. VOSTAL. Yes; and the rate of our spending would be probably higher in the year 1980.

Mr. WALKER. Are you coordinating your research at all with other diesel research that is going on by other industries?

Dr. VOSTAL. We have been in close contact with the American Mining Congress which coordinates the research on the diesel emissions in the underground mines. We have a coordinating research council which coordinates the efforts of the automotive industry and the efforts of the oil industry. Within that program there are also significant projects on the potential biological activity of diesel particulates.

Mr. WALKER. Is it your impression that the research going on in EPA is essentially research aimed at proving that, indeed, there are harmful effects from diesel exhaust that, instead of trying to show that there, in fact, may be no harmful effects, that they have been attempting to justify the fact that they believe there are harmful effects? I get that impression from your testimony when you say that they are attempting to break apart the particulates and then show that each particle may have harmful effects. That almost seems like they are weighing it in the direction of trying to say that, indeed, there are harmful effects here. Is that your impression of their research?

Dr. VOSTAL. We have to realize that the EPA has a clear mandate by the Clean Air Act. They want to be very certain before they permit the wider use of the diesel engines in passenger cars. We would not suppose that there might be any intention on their side to prevent the use of the more economical diesel engines. We feel they are concentrating too much on the possibility to differentiate all the materials which could be present on the particulates. By that, they are ignoring the fact that not all the material which is on the particulate is easily available for the interaction with the cells in the body. By that, they really ignore an important aspect of the risk assessment. It is very important that we distinguish between the theoretical basic toxicity of a compound and between a pragmatic assessment of the real risk. In the risk

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assessment process, we have to be aware of all the conditions of exposure.

Mr. Walker. In other words, the chemicals they are using to break down the diesel particles are chemicals which do not exist in the body and, therefore, you would not have that kind of breakdown taking place of the particle when it is affecting the body; is that correct?

Dr. Vostal. Yes, practically. The motivation why we have started to be more involved in this research came from the discrepancy between the findings of a simple laboratory test done on the microbes and predicting a theoretical potential for carcinogenocity and between the real life data from such studies like the study done on the garbage workers of the London Transport System where the exposure has been real. The exposure has existed for 25 years, and we have not seen any real impact on the lung cancer incidence.

Mr. Walker. Is it true, however, that the study has come under some criticism that EPA claims that it is not a valid study, that they have some problems with the type of data collection that was used?

Dr. Vostal. Most of that criticism has been raised in response to the original study which had been presented in 1957. In 1957, the conclusion of the study was negative but it was based on the exposure and observation period which was not longer than 5 years. Obviously, this is not sufficient time to permit the development of the lung cancer.

Some of the criticism which has been raised by EPA was completely shared even by us.

We have been, therefore, very much interested in generating some more interest on the side of the British Medical Research Council to continue in the studies. The opportunity is quite unique and the cohorts of the exposed people exist there even today. I think the data which has been presented in the December meeting of the EPA—and I have shown some of them here—clearly indicates that, even after 25 years of extended period of observation we don't need to change our opinion and be afraid that the diesel fumes could create a serious problem.

Mr. Walker. Let me try to summarize here. If I get the drift of what you are saying, the difference between your study and what EPA is doing, is, EPA is separating out chemicals within the diesel particles and then exposing their test subjects to very high concentrations of the particles that they separate out and, thereby, trying to conclude from that they are, in fact, harmful effects.

What your research is aimed at doing is taking the totality of the diesel-particle problem and subjecting a test laboratory—test animals or whatever—or in the case of the London study to actually have a test on human subjects, and then trying to determine whether or not if there are any health effects from the exposure to the actual particles themselves.

Is what you are telling the committee, in appearing here today, that you feel a portion, at least, of the EPA money in their budget should be used for the kind of research that you have been doing in GM? Do you think that would help us get to a more definitive kind of conclusion about diesel-health effects?

Dr. Vostal. We certainly believe so. It is not only our laboratory. The Department of Energy also has significant research being done on the potential health effects of diesel emissions at the laboratory at Lovelace Foundation in Albuquerque.

I think if you look into the program, and I assume the committee has been exposed to some of the plans of the program of the Lovelace Laboratory during its November meeting, you can see their approach is much more nearer to the approach than what we are using. It means to look for the integrated exposure rather than to try arbitrarily in the laboratory tests to define what is potentially carcinogenic and what is not.

Mr. WALKER. If EPA were to concentrate its research on the integrated level, are you convinced that they would come to the conclusive—some kind of conclusive idea that diesel particles are not, in fact, harmful to the public health?

Dr. VOSTAL. At least this is what is coming out from our data. Our data, as you have seen, have been collected on the first year of exposure. For a full year, we have exposed the animals. We have not seen, so far, any significant reaction to high concentrations of diesel emissions. Certainly we cannot predict what could still happen in the future continuation of the experiment but we would like to indicate that the more we are able to document the interaction between the diesel particulates and the respiratory system, the more certain we will be in our judgment about the potential danger of the diesel particulates.

Mr. WALKER. Your recommendation to this subcommittee would be that we try to direct EPA in the direction of the integrated studies?

Dr. VOSTAL. Yes. We certainly feel that the EPA should not only concentrate on the studies which would deal with the analysis of all the components which could be found in any fuel combustion product, but they should be more interested in the real interaction between some of those products and the cells which exist in the body. You can use many other methods.

We are now developing the methods for providing the radioactive tracer into the diesel particulates. So far we have been able to determine what is the dose of the particulate retained in the body.

Mr. WALKER. Thank you, Mr. Chairman. Those are all the questions I have.

Chairman AMBRO. Thank you, Mr. Walker.

Mr. Brown?

Mr. BROWN. I have no questions, Mr. Chairman.

Chairman AMBRO. Mr. Blanchard?

Mr. BLANCHARD. I have a couple of quick questions.

Dr. Vostal, my understanding is you agree with Congressman Walker's characterization of your testimony and his conclusions as to what you recommend for the EPA research budget. Is that correct?

Dr. VOSTAL. For the budget?

Mr. BLANCHARD. Do you agree with his characterization of your testimony; and, just for the record, because we do not deal with the regulatory aspects of the EPA, why is this research important to General Motors or to anyone dealing with energy, for example?

Dr. VOSTAL. If you look into the introduction of my testimony, you will find there are three statements indicating why General Motors has taken the initiative to introduce more diesel engines on the road. It is mainly due to the fact that these engines are more economical in the fuel consumption and, if the automotive industry has to comply with the terms of the standards for the fuel economy, there is no other way than to use the new technology like diesel engines.

Mr. **Blanchard**. As I understand it, General Motors is already spending a considerable sum of money, and I assume other auto companies are as well, developing diesel and producing it. Can you give us a figure? I've heard up to maybe $1 billion is being spent on the diesel program? Is that in the ball park?

Dr. **Vostal**. I am mainly responsible for the health effects. I cannot provide the exact numbers of how much funds were necessary to be devoted to the technical development.

Mr. **Chapman**. We have told EPA——

Mr. **Blanchard**. This is Bill Chapman of General Motors.

Mr. **Chapman**. We have told EPA that it is considerably more than that, starting the first of this year.

Mr. **Blanchard**. More than?

Mr. **Chapman**. $1 billion per year.

Mr. **Blanchard**. Is there anything else you would have to add to your testimony?

Dr. **Vostal**. No. We very much appreciate the possibility to be here. I apologize I went into some technical details but, Mr. Chairman, I thought it was important that some of the data would better clarify the specific approach of our program.

I certainly did not want to introduce here a new type of instructions. I simply thought you might find it interesting.

Chairman **Ambro**. I just said what I said at the time when the door opened, and the smells of that good cooking down the hall wafted in here. [Laughter.]

Mr. Ritter?

Mr. **Ritter**. Thank you, Mr. Chairman.

Having missed looking at scientific slides for now a couple of years, it was kind of like old home week for me. I enjoyed your presentation, but I do understand about the smells of good cooking, too.

The EPA has found some criticism with the General Motors work. Could you comment on what that criticism is, or that the General Motors work—the experimental procedures of your work—has been the brunt of some criticism. How do you respond to that criticism—the experimental methods?

Dr. **Vostal**. Mr. Ritter, I am sorry to say this is the first time I am hearing about some criticism which is coming from the EPA.

As a matter of fact, we had been invited in December to present all our data. We presented about 16 publications in an international symposium on the health effects of diesel, which was organized by EPA.

All that I have heard as the reaction to the presentations from our laboratory were only words of compliments. I haven't heard any words which would say that our research has been in some way not qualified to make the statements that we have made there.

Mr. **Ritter**. I may have that a little bit wrong. It may be coming from Environmental Sciences & Technology, an article, and certain university researchers—Dr. William Thilly of MIT, missed the work entirely saying that mutagens can immediately bind to the biological material in the obstruction fluid to making them unavailable to the test——

Dr. **Vostal**. Yes; I understand now what you have in mind.

Mr. **Ritter**. I am not quite sure I understand it.

Dr. VOSTAL. I can explain it immediately. Dr. Thilly is the head of the laboratory at MIT in the Department of Nutrition. He has been working mainly in the development of human tissues and cells methods for testing mutagenicity. We have been in close collaboration with him. As a matter of fact, he visited our laboratory just last week and gave us a seminar about the most recent advances of his research.

I think what has been written in the Environmental Sciences and Technology is some misinterpretation of his comments.

What he had in mind was practically identical with our view which is, if there is any separation of those organic compounds from the diesel particle in the body, they might be absorbed on the proteins, and the same way I have shown you the decrease in the mutagenic activity, the proteins are protecting the sensitive cells at this point. The contact with the cells is prevented and the proteins are taking it away. Now this is one of the interpretations. The other interpretation could be that there has not been any compound or too many compounds solubilized from the particle. The only solution is to develop enough of the radioactive compounds on the surface and test it experimentally in the animals. This is what we agreed between us and between MIT and will be our next program to be tested.

Mr. RITTER. That was a good way for MIT to get a GM-supported research project.

Chairman AMBRO. On that happy note, I would like to say that we must go vote. I would like to thank you very much for your testimony and ask you if you could respond to written questions for the record.

Dr. VOSTAL. Yes.

Chairman AMBRO. We have a number of them. Once more, I not only thank you, but I thank Dr. Geraldine Cox, who has been waiting so patiently. We will be back in about 5 minutes and resume our hearings.

Dr. VOSTAL. Thank you very much.

[Short recess taken.]

Chairman AMBRO. I would like to now welcome our final witness, Dr. Geraldine Cox, who is vice president and technical director of the Chemical Manufacturers Association.

Dr. Cox will speak to us about research on toxic materials and hazardous waste. EPA is asking for a major increase in funds this year to do research in this area.

We are interested in Dr. Cox' views on the quality and the appropriateness of EPA research on toxic materials and hazardous wastes.

Dr. Cox, I would like once more to apologize for the lateness of the hour. Thank you for being here and for your patience. You may proceed in any way you think is most appropriate with the assurance that we will include your entire statement in the record.

STATEMENT OF DR. GERALDINE V. COX

Dr. COX. First of all, I would like to thank you for your patience and, for those of you who survived, thank you.

You asked me to address several questions, and I have structured my testimony in that area.

The first one you asked is the quality and appropriateness of EPA research. Since EPA conducts research in two modes, in contractor research and individual research, I have selected examples of both for discussion.

CONTRACTOR RESEARCH

EPA cites an excellent example of poor contractor work as the major justification for a $100 million program for hazardous wastes, on page SW-4 of this year's budget.

The third paragraph references the Hart Study which estimates 35,000 to 50,000 dumpsites across the Nation which may contain hazardous wastes. The total project was completed in 60 days with only 4 weeks of data collection. This was based on information provided by EPA regional offices on just 103 sites.

There were data from headquarters and the contractor's file for an additional 129 sites. Only 24 sites were visited by the contractor. From a data base with absolutely no statistically based sampling of 232 sites, EPA's contractor estimated 35,000 to 50,000 sites. This is the worst of poor science.

The worst part is that EPA is using it to justify its research budget and superfund legislation. At the present time, there are approximately 4,000 identified sites which may contain hazardous waste which were collected under the following directions for Deputy Administrator Barbara Blum—and I am quoting:

> All potential hazardous waste sites or incidents must be listed on the Regional Log. This is true regardless of whether the initial identification of a potential site or incident comes from government sources, the media, or technically unsophisticated citizens complaints. * * * Some Regions have adopted a policy of adding sites to their logs only after a determination has been made that a hazardous waste problem actually exists. This policy must be changed to conform to the national model.
>
> Past concerns about the inclusion of potentially innocuous sites on the Regional Logs should be allayed by the way the logs and these initial identifications will be characterized.
>
> To eliminate our current backlog, all sites presently known to the Region, including nonduplicative sites from the Eckhardt Report, will be entered on the "Potentially Hazardous Waste Site Log" form and submitted to Headquarters by December 1, 1979.

This submission as of December 31 tallied slightly more than 4,000 sites. This is not 35,000 to 50,000 sites.

One last point on this issue. In November 27, 1979, memorandum, EPA Deputy Administrator Barbara Blum said. "A quick and dirty contractor assessment is underway in this area." Too much EPA contractor research is "quick and dirty." The taxpayer deserves careful studies, quality work, and good science for his investment.

The second area of research is EPA's own research.

EPA has mixed their research and policy/enforcement activities more than might be wise. One example comes to mind—the water quality criteria.

EPA originally issued criteria on the basis of a literature survey conducted by summer students and rewritten by Agency staff. These criteria were validly challenged on the basis of their inadequacy. The Research Division then developed a sophisticated mechanism to create a data base from a few data points. For example, a long-term chronic value could be calculated from a 24-hour acute study.

For invertebrates there was a minimum of 161 percent calculation error with 95 percent confidence. That does nothing to the errors that might be in the data used for the initial calculation.

Actual data for correction factors compared to calculated data showed individual element error ranges from 11 percent to 138 percent. A cumulatice error for saltwater invertebrates may exceed 165 percent if the data require total correction. Saltwater copper has a minimum error of 50 percent for acute studies and 90 percent for chronic studies; 4, nitrophenol has a minimum error of: freshwater, acute study, 83 percent; chronic, 103 percent; saltwater, acute, 149 percent; and 165 percent for chronic.

Extensive public comments on the invalidity of this calculation were filed with the Agency in August 1978. The EPA issued a notice in the Federal Register on March 15, 1979, saying that they had received over 50 separate comments on the criteria calculations. They said that they did not have sufficient time to review the comments before they issued the draft criteria which were calculated by this unrefined method. The criteria were issued for comment without major revision other than the water hardness interaction.

The Water Pollution Control Federation wrote to the EPA and said that the aquatic toxicity data base was so inadequate that the criteria could not be developed for toxic materials. EPA's own Science Advisory Board has told the Agency that the Blue Book criteria was the only acceptable document. The Red Book, which was developed by EPA, had too many errors.

EPA has developed a new criteria method which may not be circulated for public comment. The Agency may simply publish a set of final water quality criteria without any public input on the methodology.

Much of EPA's method development is done in an unrealistic manner. For example, last December 3, EPA issued proposed analytical methods for wastewater. To the best of my knowledge, many of these methods were developed in pure water and for single compounds. Only now, right now, is the Agency conducting a 20-laboratory interlaboratory calibration study on real industrial wastewaters. This is after the methods were proposed for public comment.

A similar situation exists in the solid waste area. EPA's section 3001 test methods for the hazardous wastes were proposed on the basis of three samples—an arsenic waste, municipal trash, and municipal sewage sludge. The American Society for Testing and Materials conducted interlaboratory studies on six different wastes. ASTM proved that the variability in the method was so great that it was scientifically invalid.

Another factor EPA often overlooks is cost. In the December 3, 1979, methods cited above, EPA proposed an inductively coupled argon plasma emission spectroscopy (ICP) method for metal analysis on the basis of its cost effectiveness. There is a similar instrument, a direct current argon plasma emission system—DCP—which sells for approximately one-half the price for equivalent performance.

Industry has many DCP's, and they have a good operating history. The lower cost for equivalent performance made the DCP sound management choice for industry. EPA has had its DCP for several years, but just recently started to evaluate it and has not developed methods for the instrument.

EPA issued methods for ICP last December but did not recognize the more common and less expensive DCP on these methods. If EPA does not allow use of this instrument, we will be unable to use the several hundred already in the industry for EPA's wastewater data requirements. ASTM will have interim methods for the DCP published in the water analysis volume this year.

The Agency should seek lower-cost methods and methods that require less skilled operators.

The second issue you raised is the problems that are hampering research quality.

In the toxic substances area, industrial toxicologists are required to meet rigorous professional standards. EPA's researchers should be required to meet the same standards if they are to critique our work or perform EPA toxicological research.

Much of EPA's research is contracted to consulting firms. The quality of the product is a function of the quality of the contractor, the time constraints, funding, and the dedication and training of the EPA contract officer and the precise definition of the scope of the work.

Unrealistically short times for contract performance are common. The earlier cited Hart Study was conducted in a total of 60 days. A longer time would have allowed a systematic and thorough analysis. Instead, EPA is going back for another "quick and dirty" study of limited value. Better long-range planning and less haste would solve many of the problems of poor quality.

Your last issue was initiatives that you could take to enhance EPA research quality.

Government groups routinely check industry toxicological studies. Why can't an independent group such as an industry contractor audit the quality of Government research? Regulations that affect the way we produce, distribute and use products are frequently based on Government studies. Industry faces the burden of these Government studies so that a designated industry representative should be able to audit the study to assure quality.

Frequently, EPA justified regulations on the basis of unpublished and even unavailable internal research. In fact, I filed a Freedom of Information Act for some information on the water quality criteria. All I received was a handcopied table of data with no references for the fruit of my Freedom of Information Act request. These data are not peer reviewed and the public cannot comment intelligently on support research they have not seen. These Government studies should stand the test of peer review before they are used to support regulations.

In theory, EPA's Science Advisory Board is supposed to perform this function. It cannot do individual project review, but it can look at major issues. For example, SAB reviewed the background documents for an atmospheric benzene standard in 1977. The SAB sent it back and asked that it be redone. Two of the same documents resurfaced with little modification even after the SAB defined their deficiencies.

EPA research should be isolated from the pressures of policy development and enforcement. Much of the poor work can be attributed to unrealistic time demands. Here Congress is often to blame. Most complex legislation is passed with a very short deadline—180 days is common. If the Agency had less pressure, they might be able to do a more professional job of promulgating scientifically based regulations and test methods.

[The full prepared statement of Dr. Geraldine V. Cox, vice president and technical director of the Chemical Manufacturers Association, is as follows:]

Testimony of

Dr. Geraldine V. Cox

before the

Subcommittee on Natural Resources and the Environment

Committee on Science and Technology

February 20, 1980

I am Geraldine V. Cox, Vice President and Technical Director of the Chemical Manufacturers Association, CMA. CMA is a non-profit trade association whose 190 United States members produce more than 90% of the basic industrial chemicals in this country. Our members are affected directly by the results of EPA research and we welcome the opportunity to present our views in this hearing.

Your letter of invitation asked us to discuss three issues:

- The quality and appropriateness of EPA research on toxic materials, hazardous wastes, and any other area that you are familiar with;
- The problems that are hampering EPA research quality; and
- Initiatives that we can take to enhance EPA research quality.

I will address these items in that order.

The quality and appropriateness of EPA research.

EPA conducts research by contract and by their own laboratories, so I will discuss each separately.

Contractor Research.

EPA cites an excellent example of poor contractor work as the major justification for a $100 million program for hazardous wastes on page SW-4 of this year's budget. The third paragraph references the Hart Study[1] which estimates 35,000 to 50,000 dumpsites across the nation which may contain hazardous wastes. The total project was completed in 60 days with only 4 weeks of data collection. This was based on information provided by EPA Regional Offices on just 103 sites. There were data from headquarters and the contractor's file for an additional 129 sites. Only 24 sites were visited by the contractor. From a data base with absolutely no statistically-based sampling of 232 sites, EPA's contractor estimates 35,000 to 50,000 sites. This is the worst of poor science. The worst part is that EPA is using it to justify its research budget *and* Superfund legislation. At the present time, there are approximately 4,000 identified sites which *may* contain hazardous waste which were collected under the following directions:[2]

> "All potential hazardous waste sites or incidents must be listed on the Regional Log. This is true regardless of whether the initial identification of a potential site or incident comes from government sources, the media, or technically unsophisticated citizens complaints. . . . Some Regions have adopted a policy of adding sites to their logs only after a determination has been made that a hazardous waste problem actually exists. That policy must be changed to conform to the national model.
>
> "Past concerns about the inclusion of potentially innocuous sites on the Regional Logs should be allayed by the way the logs and these initial identifications will be characterized.
>
> ". . . To eliminate our current backlog, all sites presently known to the Region, including non-duplicative sites from the Eckhardt Report, should be entered on the 'Potential Hazardous Waste Site Log' form and submitted to Headquarters by December 1, 1979."

This submission tallied slightly more than 4,000 sites.[3] This is not 35,000 to 50,000 sites.

One last point on this issue. In a November 27, 1979 memorandum[4] EPA Deputy Administrator Barbara Blum said, "A 'quick and dirty' contractor assessment is underway in this area." Too much EPA contractor research is "quick and dirty". The taxpayer deserves careful studies, quality work and good science for his investment.

EPA Research.

EPA has mixed their research and policy/enforcement activities more than might be wise. One example comes to mind -- the water quality criteria.

EPA originally issued criteria on the basis of a literature survey conducted by summer students and rewritten by Agency staff. These criteria were validly challenged on the basis of their inadequacy. The Research Division then developed a sophisticated mechanism to create a data base from a few data points. For example, a long-term chronic value could be calculated from a 24-hour acute study. For invertebrates there was a minimum 161% calculation error with 95% confidence.[5] Actual data for correction factors compared to calculated data showed individual element error ranges from 11.52% to 137.66%. (Buikema and Cairns, 1979.[6]) A cumulative error for saltwater invertebrates may exceed 165% if the data require total correction. Saltwater copper has a minimum error of 50% for acute studies and 90% for chronic toxicity tests.[7] 4, nitrophenol has a minimum error of: freshwater, acute 83%, chronic 103%; saltwater, acute 149%, 165% chronic.[8]

Extensive public comments on the invalidity of this calculation were filed with the Agency in August 1978. The EPA issued a notice in the Federal Register on March 15, 1979 saying that they had received over 50 separate comments on the criteria calculations. They said that they did not have sufficient time to review comments before they issued the draft criteria which were calculated by this unrefined method. The criteria were issued for comment without major revision other than the water hardness interaction.

The Water Pollution Control Federation[9] wrote to EPA and said that the aquatic toxicity data base was inadequate so that criteria should not be developed for toxic materials. EPA's own Science Advisory Board has told the Agency that the Blue Book criteria was the only acceptable document. The Red Book which was developed by EPA had too many errors.

EPA has developed a new criteria method which may not be circulated for public comment. The Agency may simply publish a set of water quality criteria as final without any public input on the methodology.

Much of EPA's method development is done in an unrealistic manner. For example, last December 3, EPA issued proposed analytical methods for wastewater. To the best of my knowledge, many of these methods were developed in pure water and for single compounds. Only now is the Agency conducting a 20-laboratory interlaboratory calibration study on real industrial wastewaters. This is after the methods were proposed for public comment.

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EPA research should be isolated from the pressures of policy development and enforcement. Much of the poor work can be attributed to unrealistic time demands. Here Congress is often to blame. Most complex legislation is passed with a very short deadline . . . 180 days is common. If the Agency had less pressure, they might be able to do a more professional job of promulgating scientifically based regulations and test methods.

Cited References

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2. EPA Deputy Administrator Barbara Blum. November 9, 1979. Memorandum. Subject: Hazardous Waste Site Enforcement and Response System.

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7. Copper Development Association. 1978. Comments on the Copper Water Quality Criterion submitted to EPA.

8. Cairns, J. Jr. and A. L. Buikema, Jr. 1979. Submission to EPA Science Advisory Board on Water Quality Criteria.

9. Water Pollution Control Federation. December 1979. Letter to the USEPA concerning Water Quality Criteria.

Chairman AMBRO. Thank you, Dr. Cox.

I would assume that one could safely characterize your statement as a criticism of EPA.

Let us take your point first, for example. EPA was—wasn't it?—under a court order, now extended to April 1980, to promulgate the hazardous waste disposal regulations under RCRA?

Dr. COX. Yes. Part of the problem with that is that there was not basic research to support some of the regulations. For instance, there is not a good system for the definition of hazardous waste. This is the ASTM test that I referenced.

The development work had not been done prior to the regulation. In fact, they developed the method on only three wastes, none of them, by the way, was organic industry waste. They had very little time to test the methods, and they were put out for public comment.

Since that time, I know more work has been done. Industry, for instance, requested that the Agency recognize the degree of hazard. The system originally proposed by EPA was an either/or—either the material was really bad stuff or it was absolutely great.

The demarcation between the two was so far to one extreme that Coca Cola, Fresca, Oak Leaves, and other materials qualified as hazardous materials. Industry's concern is that we have limited sites for material that really does require special treatment. By defining everything as hazardous, essentially, there would not be sufficient disposal facilities to protect the community from the materials that really are hazardous.

In RCRA in particular, I do not feel that background work had been done sufficiently prior to enactment and the time constraints were such that I don't think they had the time to do the research.

Chairman AMBRO. So as you correctly point out it is Congress that can take some of the shock of your assault in setting the short deadlines for EPA?

Dr. COX. I understand Congress' frustration and understand why such short deadlines are established. It is in a way to try to force any agency, and on EPA in particular, to try to come out with regulations as quickly as possible. I think we do need though to take into account the state of the art in the area that is being regulated, prior to setting those dates.

Chairman AMBRO. Let us just talk about the Hart study for a moment. You say that the study seems to have been poorly done and the taxpayer deserves good work, which is obviously valid. Was the Hart, in your view, a research program or a research study?

Dr. COX. It is difficult to isolate where research ends and data collection begins. For instance, the earlier witness talking about the acid rain pointed out that that came from other data that were being collected for other reasons.

Where do you draw the line between laboratory studies and field data collection? I am not sure, but the Hart study, to me, would not constitute an applied research program.

Chairman AMBRO. You are not implying in all of this that hazardous waste is not a problem, are you?

Dr. COX. I am not, sir.

Chairman Ambro. What is your attitude if you were to generalize on the problem of hazardous waste? How would you describe it?

Dr. Cox. We need the definition of really what is a hazardous waste. We desperately need appropriate siting for these facilities. We are concerned about the problem of abandoned landfills—the orphans. My association supports Federal legislation to work on cleaning up or containing the problems from these abandoned sites.

We do feel that the polluter should pay so that, if a problem is attributed to a company, for instance, on their own property, they should be required to clean it up; but, on abandoned sites, the ownership issue is so confused and it is such a situation that we really feel that public funds should be used on these orphans.

Chairman Ambro. That is an interesting comment. What fraction of the chemical industry, can you tell me, does the Chemical Manufacturers Association represent?

Dr. Cox. Of the basic industrial chemicals, we are 90 percent of the capacity in the United States. We have 190 members in the United States.

Chairman Ambro. One thing that is most intriguing in your testimony is your recommendation that the quality of EPA research should be reviewed by someone outside of EPA. I don't really believe, though, that you think it would be possible to set up an independent group such as an industry contractor audit of the quality of Government research. The conflicts of interest and the self-serving lack of objectivity in that recommendation are, it seems to me, clear.

Dr. Cox. Let me explain.

Chairman Ambro. Yes.

Dr. Cox. For instance, there may be three studies on the toxicological effects of a compound. One study shows considerable harm; another study is intermediate; and a third study essentially shows no harm.

If the Agency would take the worst-case-study and ignore the other two studies, could it be that there was something basically wrong in any one of the three studies? If the data were very similar, I am not sure that we would question it, but there have been instances where data are very conflicting on the same material.

I know industry has found through contractor research that by doing a quality audit, we have found errors in the study that had invalidated studies that we had done. I am sure that can happen in other areas, as well.

Chairman Ambro. Assuming we have disqualified regulated industries as disinterested or completely objective, is there any role for the Chemical Manufacturers Association, for example, to perform this kind of audit or work?

Dr. Cox. We are currently looking at the possibility of doing that right now with one study in particular, simply because the data are conflicting. It is an interesting thought; but, under the Freedom of Information Act—and I am not a lawyer—I am wondering whether or not somebody being regulated by these studies would not be allowed to look at the studies. For instance, with this water quality criteria, when I asked EPA for the supporting data, all I got was a Xerox of a handwritten table, with no justification and study backup for the material that they had quoted in the method calculation.

We in industry would not be able to submit something like that as a basis for our position on any situation, and I question whether or not EPA should have done that.

Chairman **Ambro**. So your criticism of the handling by EPA of the water quality criteria is not one just directed at the abatement or standard writing program. It is a criticism of the research program, as well?

Dr. Cox. Yes; it was the research program who developed this calculation method.

Chairman **Ambro**. Have you ever talked with anyone at EPA, or how do you interact or relate to or deal with EPA?

Dr. Cox. In many ways. In fact in 1977, I went in to meet with Dr. Guarraia, who was then head of the water quality criteria, and asked whether or not we could form a group to look at the basic methods on how water quality criteria could be developed. Dr. Guarraia said he would encourage industry participation; but, then when he talked to the other people within EPA, the issue died.

Chairman **Ambro**. I must tell you. The hour is extremely late. I ask you as I have the other witnesses if you would be kind enough to respond to written questions so we can wind up the hearing.

Dr. Cox. I would be pleased to.

Chairman **Ambro**. Mr. Brown?

Mr. **Brown**. Let me just ask one question. Does your background and acquaintance with EPA R. & D. go back far enough so that you can project a quality trend in EPA's R. & D. By that, I mean, of course, is it getting better or worse or has it remained the same?

This committee has made some of the same criticisms of their research as you have, so we can't criticize you too much.

Dr. Cox. My history dates back to about 1971 when I first participated on the Ocean Dumping Criteria Panel with EPA, to work on developing the regulations for ocean dumping. I have had EPA contracts as a contractor. I have served on several advisory panels for EPA. I have visited the Corvaillis Laboratory, the Gulf Breeze Laboratory, and Narragansett Laboratory, the Cincinnati Laboratory. I have had many interactions with people from Duluth, but I have not been to that laboratory, and I have been to some of the regional field laboratories.

I, honestly, have not seen that much of an improvement over the time. I think areas within the Agency are doing a better job than others. The toxics program under TSCA, I think, probably is doing the best program of those that I have seen.

Mr. **Brown**. Thank you.

I have no further questions, Mr. Chairman.

Chairman **Ambro**. Thank you, Mr. Brown.

Mr. Walker?

Mr. **Walker**. Thank you, Mr. Chairman.

I would just like to underscore some of your criticisms with the Hart study. I had the opportunity to visit one of the sites that was in my district. There are two sites listed, and I decided to visit one of them that was listed as a hazardous waste dump site, and found out that, in fact, there was no such thing. It was a transfer station. It didn't even handle anything that could be remotely regarded as hazardous. We have now been able to get the record corrected after talking to several industries that were involved in it and so on, but it appeared to me that there was some pretty faulty data that came out in terms of the hazardous dump site in that particular instance anyhow.

Dr. Cox. We also questioned the number of spills of hazardous chemicals in testimony last year. EPA has submitted to various people in Congress—I don't know if this group has it or not—a list of the hazardous spills. In looking through it, I saw one item which will characterize many there, and that was a spill created by a man emptying his swimming pool, which I really have trouble believing is a hazardous chemical spill.

Mr. Walker. Yes; there was another instance of another fellow that I talked to on the phone about the same matter who had his home listed as a hazardous dump site in getting into the course of that particular study, so I think that some of the points you made are valid.

I just have one short train of questioning here. If I gathered from what you were saying here a few minutes ago, you feel that one of the basic things that needs to be done is to identify what is, indeed, a hazardous waste.

Is EPA, to your knowledge, doing any research aimed at making that kind of finalized determination?

Dr. Cox. It is very difficult to answer that because, since the comments on RCRA were submitted, there has been virtually no discussion between EPA and the outside community, and in fact, EPA and any other agency other than OMB. So I will be honest with you, I don't know.

One moment. Chuck, do you know of any?

Mr. Malloy. No.

Dr. Cox. This is Charles Malloy. He is the chairman of the ASTM Committee on D–19, which is the Hazardous Waste Committee, and he is closer to it than I am.

Mr. Walker. It seems to me that you are going to have a very difficult time regulating anything in regard to hazardous waste if you don't even know what a hazardous waste is?

Dr. Cox. We agree. This is why the regulations have had such trouble.

Mr. Walker. It seems to me that then you begin to prioritize within your research and that would have to go toward the top of the list. Would that be your view?

Dr. Cox. Yes; I think that is one of the most fundamental issues that the Agency should be addressing.

Mr. Walker. Is there other research around that has been done which could be collected by EPA and be utilized as the basis for determining what hazardous waste is?

Dr. Cox. I don't think it has been looked at in that generic way. We have submitted extensive comments on what we feel is an approach for the degree of hazard. The rumor has it that the Agency is considering it; but, until we see the regulations, I don't know. We have submitted comments that are about that thick [indicating] on the RCRA regulations alone over the past year. Many of those have addressed the problem of the degree of hazard and how to approach it.

If you are interested, I could give you the whole set, but I really don't know if you want to wade through all that.

Mr. WALKER. I am not sure we have storage space.

Dr. COX. That is what I mean.

Mr. WALKER. I got the impression that you have some ideas as to what hazardous waste is in comparison with some other things. You mentioned here a little bit ago, for instance, the dumping of Coca-Cola or Pepsi or whatever on a site that should be regarded as hazardous. Although I think, my mother—back when I was a kid—used to tell me that, by drinking all the Coke, would eat away my stomach, I'm not so certain of that.

I think that, evidently, within the industry, there are some feelings about what constitutes a hazardous waste. What I am really asking is whether or not there is any kind of data base with which EPA could begin some work so that that kind of calculation could be made pretty quickly?

Dr. COX. One of the real problems is most of the toxicological screening methods have been developed for pure compounds, so that we may know the individual toxicity of a component, but we don't know about the mixture. This is one of the problems with the analytical methods.

The methods work great in distilled water; but, when you come out with glorified garbage juice, the stuff is an analytical nightmare. I worked on it in 1967 through 1970, trying to work on analytical methods for leachate from sanitary landfills, if you will excuse the expression. The biggest problem in it was in trying to get accurate data because the matrix effect—the interaction of everything there—became so overwhelming compared to the analytical technique that I don't trust any of the data that I generated in that period. It is not because of the actual measurement methods. It is the workup and separation methods that I don't trust.

So I understand EPA's dilemma. Having worked on it before, I know the problems.

Chairman AMBRO. Would you yield just a second.

Mr. WALKER. Yes.

Chairman AMBRO. I am most interested in that last point. Is there any way to leap over the matrices of the relationships and the interactions and look at the final product, for example? You have a hole in the ground, laughingly called a sanitary landfill, and you are trying to determine the effective leachates. Apart from the methods to get there, can't one look at the quality of water, let's say, in an acquifer that has been contaminated and make a judgment?

Dr. COX. It is easy to measure the migration by the resistivity of the groundwater. For instance, you know it is there, and you don't know it is there. In dilute concentrations, like you would find attenuated from a landfill; yes, you have that. In terms of the leachate itself, it is so concentrated that it is a problem; but the thing is, if you do a straight dilution on it, you are not measuring what is going on in the ground water because you get absorption on the soil particles. Do you know what a gas chromatograph is?

Chairman AMBRO. I have no idea.

Dr. COX. Have you ever gotton a Magic Marker and a piece of paper towel and gotten it wet and seen the colors separate?

Chairman AMBRO. Yes.

Dr. Cox. All right. That is what will happen in the groundwater, so that, as it moves along, some things will move faster than others, so it will be easier to measure some things.

Chairman AMBRO. I am not talking about movement though. I am talking about an inline effect. How about a bioassay? Would that help?

Dr. Cox. It depends on the type of organism, which is one of the real problems with the water quality criteria. They are very sensitive to water hardness. One of the real problems we have is the water hardness varies throughout this country so that trying to measure what will happen to an aquatic organism is a problem.

We don't have Fisher rats or Sprague Dainley rats in the aquatic system. We have only wild species. So there is a lot of genetic variation in our test animals, so the variability moves quite a bit, plus by using the aquatic organisms, you are generally dealing with coldblooded organisms, and they have a different metabolism than people who are warmblooded, so you have those problems as well in trying to come back. It is not an easy situation. I really feel sorry for EPA trying to develop these methods. I honestly sympathize with them.

The thing that we have not discussed is the predictive capability methods. That is garbage juice as it comes out, but how do you predict what is going to come out when you have a jar of muck. Is it hazardous or is it a nonhazardous problem, which is a whole different set of analytical problems. That is where EPA really is getting bogged down.

Chairman AMBRO. Thank you.

Mr. WALKER. I have no further questions, Mr. Chairman.

Dr. Cox. Sorry it was such a long answer.

Chairman AMBRO. No. It was a good answer, even though I may have understood just a portion of it. Since it is on the record, our illustrious staff will sort it out.

Mr. Ritter?

Mr. RITTER. Yes. The relative danger of these hazardous wastes—I guess it relates to what Mr. Walker was talking about of how hazardous is hazardous waste. Is there data base on this now in industry? Is industry working on these problems? I understand EPA is not talking too much to industry in some of these areas.

Dr. Cox. Right.

Mr. RITTER. According to your testimony, they have developed new criteria which may not be circulated.

Dr. Cox. That is on water quality criteria. That is a different issue. That is the toxics area. The thing that has me concerned on the water quality criteria is, if we had that many problems with the first two go-arounds, to have them come out in final form without a public comment on them, we may have the same set of problems.

The real crux of the matter is that water quality criteria are criteria, and they will be used by the States. EPA will tell the States to set standards that meet the criteria as a minimum, but there is a real fine line whether the criteria are a document that must be subject to public comment. If that is the case and if the criteria are really a problem, industry or anybody else who wishes to challenge those, would have to challenge them in each of the 50 States because that is our only legal mechanism, and that is highly expensive. I really would like to see them available for public comment. Let the Science Advisory Board work on them and let other people work on them. It does not have to be industry to try and get scientifically valid material.

Mr. Ritter. But it would seem to me to establish validity, availability for public comment within the scientific community, should be a must.

I guess the next thing—and the last thing, too are—you familiar with the current legislative initiatives being taken to deal with the hazardous waste problem, and are there a number of them?

Dr. Cox. Which one?

Mr. Ritter. What is your comment on the general drift of these legislative proposals? Are there any that would, in your mind, be viable, I guess, without knowing what hazardous wastes really are, which seems to be where we are? We are going forward very, very strongly with some of the legislative proposals which are certainly going to scare the heck out of everybody.

Dr. Cox. My concern there is what has happened is, essentially, taxation without representation because they are trying to get an industry-paid fee to work on this problem.

Industry is concerned, first, with the scope of the problem; secondly, the liabilities; and, thirdly, is the funding mechanism.

If we had gone from 50,000 sites to 4,000, and yesterday Gus Speth said there were 1,200, that may be problem sites—in a press conference yesterday, Gus Speth said there were 1,200——

Mr. Ritter. So it has gone from 50,000 to 4,000 to 1,200——

Dr. Cox. Yes.

Mr. Ritter [continuing]. Hazardous dump sites?

Dr. Cox. That may contain hazardous wastes.

My question is are we proceeding too quickly. What we need to do is scope the problem to find how big is it, and then develop legislation that would be appropriate to addressing the real problem.

Mr. Ritter. Are you saying that the legislation currently put forth is premature?

Dr. Cox. I think so because they are requiring something like a $1 billion industry fee, with a $700 million-a-year cashflow on the system. That is an awful lot of money because industry is going to be paying to clean up their own sites. What we are questioning is the data base upon which this is based. We are requesting that a good study be done to define the problem.

As I quoted here from a Barbara Blum memorandum, she is saying anything that it may possibly contain should be listed.

It is essentially a situation where they are trying to build up the numbers on the basis of "from the media or unsophisticated citizen complaints." Now that really is not a thorough scientific study. It does not even mean that they have been to the site.

Mr. Ritter. Mr. Chairman, has this committee promoted such a thorough study of hazardous wastes in the past, or are we sort of getting hit from the media and the unsophisticated citizen complaints situation as well?

Chairman Ambro. I don't know how to accurately respond in terms of a period of time. I think it might be said that this committee has promoted a variety of thrusts by EPA, including hazardous wastes and, as you very well know, acid rain, groundwater, and others, which—you were here yesterday and heard—are, in many cases, given short shrift by EPA and OMB and other agencies developing their budgets. When asked about the impact of congressional intent in the priority process, I think the response was that there is not much.

I don't know if that answers your question. I don't know how far back you want to go. I would say, yes, we have; and we have, as well, been somewhat successful in motivating or tilting the EPA.

Dr. Cox. May I add one other thing from this Barbara Blum memo, and I am reading the direct quote here:

> You should be aware that the Department of Justice has indicated that it will require only a reasonable showing to bring cases in the hazardous waste area and that the task force is prepared to work closely with the regions in expediting case development and resulting litigation referrals.

The bottom line in the enforcement area is obviously the number of cases filed. I will leave this entire document with you. I think it makes very interesting reading.

Mr. Ritter. Thank you very much.

Chairman Ambro. I just want to pursue one more thing. This whole business of an independent or outside group looking at the quality of research being done, I asked you earlier what your thought was with respect to CMA doing it. I think your response was "we are considering it." What does that mean? How are you considering it; have you costed it out; in what specific area are you considering it?

Dr. Cox. We have made initial contact with NCI and one other agency on ethylene dibromide. There are two studies with conflicting results, and we have asked that we be allowed to audit these studies. We have been told that we are not allowed to look at those studies until they are completed and the final report is written.

The problem that we have on that particular issue is that we cannot go in and see the physical housing of the animals. One of the problems that has happened in the past, and I do not know that this is a case where control animals and exposed animals were housed in the same room and contamination occurred.

There is another problem in looking at the analytical instrumentation that is being used and looking at the reference samples and calibration of the instruments. This cannot be done retrospectively. It needs to be done while the study is being done.

We would also monitor a certain percentage of histopathological slides to see whether or not the diagnosis was consistent. We would not do it ourselves. We would hire an outside group. In fact we would use an audit contractor that was probably used by NCI or another agency. We would not do it ourselves.

Chairman Ambro. If you set a precedent, for example, in EPA in reviewing the quality of their research and if, in fact, that became a precedent for reviewing the quality of research of other departments and agencies, which have the same structure as EPA, that is, regulations, theoretically based on research, such as DOE, the FDA, and others, would we be getting into an unrealistic maze here?

Dr. Cox. This is why I said an appointed industry group. One of the concerns I would have if I were in EPA would be, for instance, six groups all come trooping in and wanting to look at the same things. If the groups who were interested, got together, pooled resources, and selected an agent to do that so that it would only be one, I think that might be useful. Now, I am not saying that this need to be done on all work, but a lot of the Government research directly affects the way we eventually do our business; and, if there is a flaw in the science behind it, we should be able to take a look at that study and determine whether or not there is a problem and surface it if it exists.

Chairman Ambro. Who would arbitrate and make a final judgment on a dispute that might arise between you and EPA scientists or researchers?

Dr. Cox. In the present mechanism, that is being done in the courts of law. The *Benzene* case, for instance, is in the Supreme Court right now.

Chairman Ambro. If we are talking about obviating that situation and moved in the direction you recommended, who then would arbitrate the dispute. How would you work together on this?

Dr. Cox. Even looking at the track record of the Science Advisory Board which is looking at EPA work and followed their recommendations versus what has changed in EPA, I think you will find an interesting comparison there.

The Science Advisory Board has no authority. They can only review and recommend.

I am not sure we are to the point where we are reading for a science court, but I feel sorry for judges of law who must try to determine issues of fact when they are highly complicated.

For instance, if you get two statisticians both arguing an approach, the poor judge who is not a statistician is forced with rather a serious problem as to who to believe.

We are getting into a science base bureaucracy, and there needs to be a mechanism to review the science, which is the basis of the regulations.

Chairman Ambro. Well, I think any further discussion of this would probably take us far outside the jurisdiction of this subcommittee, except to suggest, if the Science Advisory Board does review the quality of research in part—I say in part because——

Dr. Cox. They don't look at everything.

Chairman Ambro [continuing]. Some of them only have 15 or 20 people. Obviously, they do not have the capability either in terms of personnel or resources to do all of that, and it may very well be that, if this recommendation is refined, it might take the initial form of a pilot project to review one ingredient of research being engaged in by EPA with a group that you suggest be set up to see how it works and how it interacts. It may be that we, therefore, can then obviate the necessity of court challenges if the procedures and methods are agreed upon in advance by both sides.

Anyway, it is something worth considering.

Dr. Cox. To a slight degree, that happened with the 311 regulations where the judge said, "There are too many issues of science here. The parties should get together and negotiate," and the consent decree, I think, was in fact part of that type of negotiation.

Chairman Ambro. But, of course, that is after the fact, and what we are talking about is that which could be done on parallel tracks beforehand so that we might come to a much better modus vivendi between the regulation writers and the research arm on the one hand and the Government sector and the private sector which is regulated.

I don't know. It is certainly worth considering. You have stimulated a number of ideas, and I appreciate both, again, your patience and your testimony.

Dr. Cox. Thank you.

Chairman AMBRO. I declare these hearings closed.

[Whereupon, at 7:50 p.m., the hearing was adjourned.]

APPENDIX 1

STATEMENT ON INDUSTRIAL HYGIENE SURVEY OF BARIUM NITRATE EXPOSURES AT THE LOS ALAMOS SCIENTIFIC LABORATORY DURING THE PERIOD 1950 - - 1953

by

Edwin C. Hyatt
Industrial Hygienist
Los Alamos, N M

This statement was requested by Congressman Robert McClory of Illinois. The purpose is to help clarify some apparent misunderstanding relative to our industrial hygiene survey of barium nitrate discussed in the paper titled "Experiences with Unusual Materials and Operations" by E. C. Hyatt and M. F. Milligan, Ph D and published in the American Industrial Hygiene Association Quarterly in December 1953 (reprint attached).

I have learned from Dr. Robert Larsen of the Argonne National Laboratory that apparently the standard for barium in drinking water is partly based on our studies of barium nitrate dust exposures reported in the paper noted. This is the apparent misunderstanding noted and may have resulted in drawing incorrect conclusions from our studies.

The paper noted is a brief discussion of our industrial hygiene surveys and studies with 15 different compounds and/or elements at the Los Alamos Scientific Laboratory during the period 1950-1953. The workmen's inhalation exposures were evaluated by collecting air samples in their breathing zone or by general air (area) sampling. The airborne concentration results were compared with the threshold limit values (TLVs) recommended by the American Conference of Governmental Industrial Hygienists (ACGIH). Under the subheading barium nitrate in this paper, it states the permissible concentration recommended by the ACGIH for soluble barium compounds is 0.5 milligrams per cubic meter calculated as barium. Also, the paper notes the results from approximately 100 analyses (of air samples) showed the average air concentration (of barium nitrate) was well below the permissible limits (TLV).

For the purpose of this statement, threshold limits are the widely used values published annually by the Committee on Threshold Limits of the ACGIH. In 1955 the Committee gave the following definition of threshold limits as "the maximum average atmospheric concentration of contaminants to which workers may be exposed to for an 8-hour day without injury to health". I wish to emphasize that the TLVs recommended by the ACGIH relate only to inhalation exposures and are not recommended as TLVs for ingestion of contaminants in drinking water.

The ACGIH published its 1950 TLVs in the Archives of Industrial Hygiene and Industrial Medicine (Volume II, p. 98-100). The TLV listed for barium is 0.5 milligrams per cubic meter of air. Prior to the first TLVs (1947) by the ACGIH, Warren Cook collected and published a list of "maximum allowable concentrations of industrial atmospheric contaminants" in the Journal of Industrial Medicine (14:11, 936-946, November 1945). In this paper, Cook listed only barium peroxide (as barium) with a maximum allowable concentration of 0.5 milligrams per cubic meter of air which had been proposed as a guide by the U. S. Public Health Service in 1943. This is noted because someone may wish to investigate the source of the ACGIH TLV for barium that we referenced in our paper published in 1953. Beyond the references noted, the source of the recommended 0.5 milligrams per cubic meter as a TLV for barium is not known.

I wish to emphasize that the ACGIH TLV for barium is not based on barium nitrate air sampling data collected at the Los Alamos Scientific Laboratory and described in the above paper. I emphasize that I am an Industrial Hygienist, not a toxicologist. Also, that our industrial hygiene studies described in the paper noted above are in no way studies on the toxicity of barium.

BARIUM IN DRINKING WATER

A Statement Prepared by

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October 1979

There are four types or categories of scientific information that are used to establish an upper limit for the concentration of a constituent of drinking water that is toxic in nature: (1) knowledge of the amount which is fatal if ingested as a single dose; (2) knowledge derived from epidemeology studies of population groups whose health problems are the result of diets (food and/or water) having elevated concentrations of the constituent; (3) observation of an adverse health effect in industrial workers who have been chronically exposed to elevated concentrations; and (4) laboratory studies using animals in which an adverse health effect has been shown to be due to elevated concentrations of the constituent in their diet.

Scientific information means (1) that trained individuals have made observations which definitely established a cause-effect relationship, and (2) that the information has been published as an article in a reputable technical journal with that article having been reviewed and accepted by one or two other trained individuals who are knowledgeable in this field of research or a closely related one. Furthermore, it has been general practice to consider the findings of a single investigator as being scientific fact only when similar or comparable observations have been made by another investigator (i.e., there have been two industrial, or two animal investigations or a combination of these).

In the case of barium the only scientific information that exists about its toxicity is the amount that constitutes a lethal dose. There have been no epidemeology studies, there is no evidence of toxic effects as the result of industrial exposure, and no animal experiments have been carried out which show that elevated concentrations in diet have an adverse health effect.

The value of 1 mg per liter that has been set is based on the work of Stokinger and Woodward. They calculated a value for drinking water from a value for barium in air. Of the calculation it can be stated unequivocally that it was performed incorrectly. Of the basis for the calculation, the barium in air number, it can be stated that I have been unable to find any scientific evidence for its validity. E. C. Hyatt, an expert in the area of industrial toxicology, has traced the use of the air value to a 1943 report published by the National Bureau of Standards. This document reports the value for a specific barium compound, barium peroxide, but the source or reason for the value is not given. It appears therefore that for reasons unknown, someone, at some time, made what can, at best, be characterized as an educated guess about low level toxicity. This is obviously not scientific information nor should it be the basis for a drinking water standard.

There is every indication in the Stokinger and Woodward paper that they did not have sufficient confidence in their value to warrant its being used as the basis for a federal regulation affecting a large number of people, even after the EPA had reduced their value by a factor of two. They stated that their value was "only a first approximation in the development of a tentative drinking water standard."

The only information that is available which could serve as the basis for establishing a drinking water standard for barium is the value for a lethal dose. If this approach were to be used, research would have to be done to establish the values of other factors that would be needed to arrive at a standard value. It may be that the presence of sulfate in the diet and the known property of barium and sulfate to react chemically to form a compound that is highly insoluble forestalls barium uptake. Although this is speculative as it does not include other factors that may be important, it is hardly more speculative than that which is contained in the Stokinger and Woodward publication.

A critical evaluation of the section on barium in the EPA publication, "Drinking Water and Health" reveals that the qualifications of the author was either not commensurate to the task and/or that he was extremely careless. I have found (and there may be more) three separate pieces of information in this section that are either factually incorrect or are misinterpretations of the original authors data: the studies made with radioactive barium have nothing to do with the absorption of barium from the gastrointestinal tract, barium has not been shown to be beneficial when fed to animals (the observation was that its exclusion from the diet was detrimental), and the limiting value for barium in air was not based on the effects of barium on workers at the Los Alamos Scientific Laboratory. Stokinger and Woodward were either not aware of the Los Alamos data or recognized that it wasn't germaine.

Conclusion: The EPA value of 1 mg per liter for barium in drinking water has no valid basis and because there is no evidence that the consumption of drinking water having concentrations in the range 5 to 10 mg per liter has an adverse effect on health, the treatment of a drinking water supply to remove barium is pointless. Barium is only one of the thousands of the natural constituents of man's diet for which there is no information and there is no special reason why barium should be singled out for an investigation. For those constituents which are chronically ingested, the position one must take is that each must be considered to be benign until evidence to the contrary surfaces. The position of dangerous until proven otherwise will ensure the employment of thousands of scientists for decades to come but as a scientist I am convinced that the benefits derived if this position is taken will not be commensurate with the costs.

Statement on Barium in Drinking Water

Submitted by Dr. R. E. Rowland

The Safe Drinking Water Act of 1974, Public Law 93-523, authorized the Environmental Protection Agency (EPA) to establish Federal standards for drinking water. This statement examines the standard for barium and demonstrates that the maximum barium concentration allowed in water was not based on information derived from toxicity data but was chosen rather arbitrarily. Specifically, the maximum concentration has been set at 1 mg barium per liter of water. This value was based on an observed barium concentration in air which caused no harm, which was subsequently transformed into a supposedly equivalent concentration in water. Unfortunately, this transformation was based on an erroneous estimate of the absorption of barium from the intestines. Since the EPA's enforcement of this concentration is causing unnecessary financial problems for community water systems, it is proposed that the standard be revised.

The history of the derivation of the 1 mg per liter limit for barium in drinking water is well summarized in this quotation from the EPA publication "Water Quality Criteria--1972."

> "There apparently has been no study made of the amounts of barium that can be tolerated in drinking water, nor any study of the effects of long-term feeding of barium salts from which a standard might be derived. The present barium standard has been developed from the barium-in-air standard, 0.5 mg/cubic meter (m^3) (American Conference of Governmental Industrial Hygienists (1958)) based on the retention of inhaled barium dusts, and an estimate of the possible adsorption from the intestines (Stokinger and Woodward 1958). This value is 2 mg/l. The air standard provides no indication of the inclusion of a factor of safety. Therefore, it is reasonable to provide a factor of safety of 2 for protection of heterogeneous population."

The barium-in-air standards were apparently derived from observations of workmen shoveling powdered $BaNO_3$ at Los Alamos National Laboratory. These workmen experienced no ill effects at an observed air concentration of 0.5 mg barium per cubic meter (Hyatt and Milligan, Experience with Unusual Materials and Operations, American Industrial Hygiene Association Journal 14: 289-293 (1953)). We have no way of knowing whether they would have shown any effects had the concentration been 2, 5, or 10 times as great.

This value for barium in air was then transformed into a barium-in-water standard (Stokinger and Woodward, Water Quality Standards, J. Amer. Water Works Assn. 50: 515-529 (1958)). At one step in this transformation a serious error was made, for the authors assumed that 90% of the barium that entered the gastrointestinal tract would be absorbed into the blood. As will be documented below, this value should have been 20%. Therefore, had the barium-in-air standard some credibility, the value of the barium-in-water standard derived from it, 2 ppm (2 mg per liter), should be increased by a factor of 4.5.

Nevertheless, it appears that the barium-in-air standard has been accepted uncritically, and that the error in the absorption standard from the gastrointestinal tract has not been recognized. Therefore, the EPA has set a standard of 1 mg/l for barium in public water supplies.

Barium is a member of the alkaline earth family, and is similar in many respects to the other members. In order of increasing atomic weight, this family consists of calcium, strontium, barium and radium. On this basis one might assume that the permeability of the digestive system to barium could be estimated from the known data for strontium and radium. A summary of all such information for man appears in a report issued by the International Commission on Radiological Protection (ICRP), entitled Alkaline Earth Metabolism in Adult Man (ICRP Publication 20, 1973). It states that the fraction of these elements transferred from the digestive system to the blood is 0.19-0.21 for strontium, unknown for barium, and 0.15-0.21 for radium (Table 27, p. 72).

One might assume, then, that a reasonable value for barium is about 0.2, i.e., 20%. Is there any evidence for animal studies to support such an assumption? The answer, of course, is affirmative. For example, a report entitled "The Absorption of Calcium, Strontium, Barium and Radium from the Gastrointestinal Tract of the Rat" (Taylor, Bligh and Duggan, Biochem. J. 83: 25-28 (1962)) provides exactly the information required. As expected, the absorption of barium was usually observed to fall between that of strontium and radium; all values were dependent upon the age of the animals studied. For 60-70 week old rats, the percent of administered dose absorbed was 11.1, 7.5, and 3.2, for strontium, barium and radium, respectively, while at age 6-8 weeks the values were somewhat different, namely 24.6, 6.8, and 11.3 percent. The conclusion is unmistakable; the absorption of barium is not as high as 90%, 20% appears to be a more reasonable value for man.

In the near future a report will be published which might be thought by some to support the need for a barium standard as low as 1 mg/l for water supplies. This report is entitled "Cardiovascular Disease Death Rates in Communities with Elevated Levels of Barium in Water," by Brenniman, Namakata, Kojola, Carnow and Levy, and will appear in the journal Environmental Research. This report will describe a study which observed higher death rates for "all cardiovascular diseases" and "heart disease" in communities with high barium levels in their water supplies as compared to other communities with low barium levels in their water. The authors are very careful, however, not to ascribe the results to the barium content of the water. They state, "Since there was a greater population change in some of the high barium communities compared to the low barium communities and no method for controlling for removal of barium by home water softeners, any inferences drawn about this finding must be interpreted with caution."

Consider the fact that the higher the barium content of a water supply the more likely it is that high levels of other minerals, such as calcium, will also be present. Thus, one could postulate that the more barium in the water the greater the total hardness of the water, and therefore the more likely individual homeowners would take it upon themselves to soften their water. All such softening devices will remove barium from water with high efficiency. The above report made no effort to determine whether the cases of cardiovascular disease came from homes with or without water softeners. It is this uncertainty which makes such studies hard to interpret; even more so if one recognizes that the softening processes add sodium to the water in the place of the elements removed, and sodium has long been suspected as a cause of cardiovascular problems.

Finally, it should be noted that two of the four cities that constituted the high barium communities in this report experienced approximately a 75 percent change in population between 1960 and 1970. These two cities contributed 71% of the high barium population. Since the study covered the period 1971 to 1975, and since it would be expected that the effects (if any) of such low levels of barium would require many years before they could appear, it is obvious that most of the residents had not lived in these communities long enough to have been affected.

These observations make it clear that this study does not and could not demonstrate any effect of barium in drinking water.

Conclusion

The current standard of 1 mg per liter of barium in drinking water is not based on any evidence of toxicity at this concentration. If the concentration of $0.5\ mg/m^3$ for barium in air is accepted as being safe, then the equivalent concentration of 10 mg per liter in water (derived by eliminating the absorption error and the factor of two introduced for safety), should be set as the current best standard for barium in drinking water.

Adoption of a standard of 10 mg barium per liter of water would save millions of dollars annually, which would otherwise have to be spent to achieve conformity with the law. Softening of water supplies to remove barium adds sodium to the drinking water; it has been postulated that sodium is related to increased incidence of cardiovascular problems. I suggest that if softening is required because of barium in the water supply, the cure may be more hazardous than the problem itself.

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Trace elements in water and congenital malformations of the central nervous system in South Wales

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Morton, M. S., Elwood, P. C., and Abernethy, M. (1976). ***British Journal of Preventive and Social Medicine*, 30, 36-39 Trace elements in water and congenital malformations of the central nervous system in South Wales.** The concentrations of 20 trace elements were determined by atomic absorption spectrophotometry on representative samples of tap-water collected from 48 local authority areas in South Wales. The associations between twelve trace elements and central nervous system (CNS) malformation rates for the 48 areas were examined. Significant correlations for four trace elements were observed. Of these, Al was positively correlated while for the remaining three—Ca, Ba, and Cu—negative associations were found. Regression analysis of the data suggested that the relationships between Ba and Cu with CNS malformation rates were more important than those of Al and Ca.

There are large regional differences in the incidence of congenital malformations of the CNS in the British Isles (Edwards, 1958; Rogers, 1969; Elwood, 1970), and for South Wales in particular marked local area differences have been reported (Laurence, Carter, and David, 1968, Richards, Roberts, and Lloyd, 1972).

Penrose (1957) first made the suggestion that 'the geographical variations observed in the incidence (of anencephalus) might suggest . . . . . a causal agent, such as the presence or absence of trace elements in the water supply'. Following this suggestion Fedrick (1970) found that the incidence of anencephaly in 10 areas of the United Kingdom was negatively correlated with the total hardness, pH, and to some extent the sodium content of the local water supply.

In the same year Stocks (1970) demonstrated that death rates of women aged between 25 and 54 years from cardiovascular diseases show a closely similar regional distribution in England and Wales as that for neural tube malformations. This is of interest since mortality from cardiovascular disease in the county boroughs of England and Wales has been shown to be strongly associated with the softness of their water supplies (Crawford, Gardner, and Morris, 1968a, b), although Roberts and Lloyd (1972) recently suggested that this association is a secondary (non-causal) one.

In contrast to the findings cited above, Fielding and Smithells (1971) observed that for several towns in south-west Lancashire, the incidence of anencephalus has so far shown no relationship with water hardness. Similarly Wilson, Watson, and Richards (1973) investigating the possible relationship between area difference in anencephaly in Glasgow and water supply concluded that acidity, hardness, and metal concentrations (lead, copper, zinc, and iron) were not responsible for the area difference.

However, with particular reference to South Wales, Lowe, Roberts, and Lloyd (1971), dividing the region into 48 local authority areas, reported a negative correlation between the incidence of CNS malformations and the total hardness of the related water supply. An analytical epidemiological study was made of the problem and such a study forms the basis of this report.

MATERIALS AND METHODS

Hardness of water is a crude measurement of total calcium and magnesium levels which give little or no information about other elements which may be present (data from this study which have been presented elsewhere show that although for most elements correlations between 'hardness' and separate trace metal concentrations are significant, only that for calcium is really high (Elwood, Abernethy, and Morton, 1974). The present study was initiated to examine in detail any relationships there may be between area difference in CNS malformation rates in South Wales and the concentrations of 20 elements in the domestic water supply.

The area surveyed was exactly as that defined by Lowe *et al.* (1971) from which data for the incidence of neural tube malformations were taken. For direct comparison purposes the same division into 48 local authority areas was also maintained.

Within each of the 48 areas, 20 electors were selected at random and each was asked to draw two samples of tap water during a day in July 1973. To obtain the first sample the subject was asked to fill a clean jug with the first run-off from the kitchen tap, and from this to fill a polystyrene sample bottle (30 ml, Sterilin Limited, Surrey). Another sample bottle was to be filled at any time during the evening. Altogether 20 pairs of samples were requested within each area, at least 15 pairs were actually obtained, and in most areas 18 or more were returned. All the morning samples from each area were then pooled into high-density, acid-washed polythene bottles (1 litre Kernick & Sons, Cardiff). The evening samples from each area were similarly combined.

The bulked samples were then treated with Aristar concentrated nitric acid (to give a nitric acid concentration of 2% v/v) and stored at 3°C before analysis.

REAGENTS

All reagents used were of analytical grade and working standards for atomic absorption were freshly prepared each day from commercially available (May and Baker or British Drug Houses), bulk standards (1000 ppm) diluted with de-ionized water (prepared from Elgastat 2000 De-ioniser fitted with a C810 barrel, supplied by the Elga Group, Buckinghamshire).

INSTRUMENTATION AND METHODS

The concentrations of 20 trace elements (Na, K, Ca, Mg, Cu, Mn, Co, Fe, Zn, Pb, Cd, As, Ni, Tl, Be, Li, Al, Si, Ba, and Cr) were measured using a Varian-Techtron AA 1200 Atomic Absorption Spectrophotometer, fitted either with a standard air-acetylene burner or a Model 63 Carbon Rod Atomiser. The instrument was linked to a Smiths Servoscribe 1S chart recorder.

STATISTICAL METHODS

Statistical analyses of these data were difficult, as the distributions for many elements were highly skew. A non-parametric technique (Spearmans rank correlation) was therefore used, followed by multiple regression analyses based on data transformed to $\log_{10}$. These methods are similar to those used in a parallel study derived from the same source (Elwood *et al.*, 1974).

In drawing conclusions from a large series of correlations, there is an increased probability of statistical significance being achieved by chance alone in a few of the tests. An attempt to limit this occurrence has been made by considering the pairs of correlations based on morning and evening water samples together, and selecting for further consideration only those elements in which both are significant and consistent in sign.

RESULTS

The data for eight trace elements (As, Cd, Co, Fe, Ni, Li, Tl, and Be) were discarded as the major proportion of the estimations were below the detection limit of the atomic absorption spectrophotometer. Data for the remaining elements (Na, Mg, Al, Si, K, Ca, Cr, Mn, Cu, Zn, Ba, and Pb) were then analysed. The data for Ba should have been excluded as 14 of the estimations on morning samples and 11 on evening samples were below the limit of the instrument, but after assigning an arbitrary low level to these, certain correlations were found to be significant for this element and the data were subsequently included in most of what follows.

Table I shows that in general levels in the morning samples are more scattered and have higher means than the evening specimens, and for three elements (Cu, Zn, and Pb) these differences may be important. Data from morning and evening samples are therefore kept separate throughout.

Analysis of the trace metal data with respect to CNS malformation rates (taken from Lowe *et al.*, 1971) showed that four elements (Al, Ca, Cu, and Ba) were significantly correlated. Of these, Al was positively correlated with the malformation rates, while the remaining three elements were negatively correlated. (Table II).

TABLE I

MEANS AND STANDARD ERRORS OF TRACE ELEMENT ESTIMATIONS ON 48 SAMPLES OF TAP WATER BY TIME OF COLLECTION

Trace Element	No.	Morning Samples	Evening Samples	Difference
		Mean ± S.E. mg/l	Mean ± S.E. mg/l	Mean ± S.E.
Sodium	48	7·0 ±0·92	6·9 ±0·85	0·1 ±0·103
Magnesium	48	5·2 ±0·56	5·1 ±0·55	0·1 ±0·025*
Aluminium	48	0·061±0·0136	0·049±0·0054	0·012±0·009
Silicon	48	0·21 ±0·025	0·20 ±0·025	0·01 ±0·007
Potassium	48	1·11 ±0·106	1·04 ±0·090	0·07 ±0·036*
Calcium	48	25·6 ±2·34	25·2 ±2·31	0·4 ±0·074*
Chromium	48	0·021±0·0005	0·019±0·0005	0·002±0·0003*
Manganese	48	0·023±0·0071	0·014±0·0018	0·009±0·0047
Copper	48	0·26 ±0·043	0·11 ±0·023	0·15 ±0·036*
Zinc	48	0·203±0·0229	0·086±0·0118	0·117±0·0108*
Barium	48	0·042±0·0055	0·046±0·0060	−0·004±0·0026
Lead	48	0·017±0·0019	0·010±0·0011	0·007±0·0006*

Note: Some of these means are based on skew distributions
*Significant at P<0·05

TABLE II

SPEARMAN'S RANK CORRELATION COEFFICIENT FOR TRACE ELEMENTS IN TAP WATER VERSUS CONGENITAL MALFORMATION RATES FOR 48 AREAS IN SOUTH WALES

Trace Element	Spearman's Correlation Coefficient	
	Morning Samples	Evening Samples
Sodium	−0·284	−0·285
Magnesium	−0·150	−0·129
Aluminium	0·305*	0·313*
Silicon	0·171	0·094
Potassium	−0·111	−0·139
Calcium	−0·297*	−0·306*
Chromium	0·094	−0·144
Manganese	0·211	−0·039
Copper	−0·416*	−0·376*
Zinc	−0·140	−0·087
Barium	−0·330*	−0·438*
Lead	−0·135	−0·101

*Significant at P<0·05

Regression analysis showed an inconsistency in the signs for Ca and in the size of the coefficient for Al at the two times of sampling, which makes it unlikely that these two elements are important. Cu and Ba appear to be the most important elements in the context of CNS malformations, but only for Cu are the regressions significant for both the morning and evening samples. Copper alone explains about 16% of the variance in the malformation rate and the addition of Ba increases this to about 19% in the morning samples and 29% in the evening samples.

DISCUSSION

It is now generally agreed that atomic absorption spectophotometry is a most acceptable method of water analysis, offering sensitivity and accuracy to research programmes demanding the analysis of many thousands of samples, some of which may have been stored for over two to three months under conditions of low temperature and pH.

The data obtained from this survey are complex and our investigations are at a much too early stage to enable any firm conclusions to be drawn. Copper and Barium both have significant negative associations; only Cu is fairly consistent in size at the two times of sampling. Although the association with Ba is less impressive than that with copper, the fact that a significant relationship was detected when about one-quarter of the areas had had to have an arbitrary low level of Ba assigned to them might suggest that an important relationship may exist between this element and CNS malformations.

It is of interest that elements that have attracted particular attention from animal teratologists have so far, in our investigations, shown no correlations with CNS malformation rates. Examples may be cited of experimental animals maintained on diets low in Zn (Warkany and Petering, 1973) or high in heavy elements such as Pb (Ferm and Carpenter, 1967), Cd (Chernoff, 1973) and As (Ferm and Carpenter, 1968) giving birth to malformed offspring although the malformations are not always of the central nervous system. In the light of such animal experiments, it would obviously be of tremendous value, although an enormous task, to determine the contribution that diet as a whole makes to the trace element status of the population in South Wales. Furthermore, valuable data might be obtained by measuring the trace element status of the blood of women in the early stages of pregnancy.

However, the data reported clearly indicate a need for further study, not only along the lines already employed, but also covering much wider aspects such as diet and maternal blood levels, and we are at present planning further studies throughout the United Kingdom in general and South Wales in particular.

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Insight

Trace Elements in Human Health and Disease: IV. Influence of Trace Elements on Development and as Environmental Toxicants

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> *. . . trace mineral nutriture may influence development both in utero and post utero, and can have its influence directly at the genetic level or at an epigenetic level, influencing the development process.*

Although a century ago the first indications arose that trace elements could be of physiologic importance for mammals, it was not until 1957 that there was discrete information concerning the essentiality of seven trace elements in human metabolism: iron, iodine, manganese, zinc, cobalt, molybdenum, and copper. Since then, seven more trace elements have been proven essential: selenium, fluoride, chromium, tin, vanadium, silicon, and nickel. There is increasing information[1-3] relating the importance trace minerals have on maintenance of proper human physiology. Examples have been found where there is a purported interaction between a genetic factor and a specific trace element during development, which may lead to altered embryogenesis and produce potential teratogenic effects. The interactions between trace elements and genetic factors in development presently known are classified into two types. One interaction involves a single mutant gene whose effects resemble a deficiency of a specific element, and whose deleterious effects may be prevented or ameliorated by prenatal nutrition manipulation. The second interaction involves certain differences that may lead to differential responses to dietary deficiencies, consistent with the concept of biochemical individuality.[4]

Weston Price[5] demonstrated the importance nutritional balance of selective minerals may have in establishing the outcome of a pregnancy. This same observation is reinforced by Francis Pottenger,[6] who investigated the influence various nutritional regimens have on the development of dental/facial structures in experimental animals. These early studies, along with more recent studies, paved the way for awareness of the influence that trace minerals have on the prenatal and postpartum development period. As described by Hambidge,[7] nutritionists are sensitive to the importance of trace minerals in pediatric nutrition. This work shows that trace mineral nutriture may influence development both in utero and post utero, and can have its influence directly at the genetic level or at an epigenetic level, influencing the development process.

Work on interaction between genetic factors and the trace minerals manganese, copper, and zinc exemplifies this influence. When young animals are given a diet deficient in manganese, abnormality of the skeleton may result.[8] Abnormal development of the tibiometatarsal joint, disproportionate shortening and curvature of the long bones, and growth of the skull are all seen. If the diet of the maternal animal is deficient in manganese, the mother's offspring then will exhibit effects including congenital ataxia, which is characterized by retraction of the head, incoordination, and lack of equilibrium. Trace mineral deficiencies any time during the development process may have a significant effect on development, but the time at which these deficiencies occur may distinctively influence the type of development alteration.[9,10]

Manganese

Hurley and associates[8] indicate that the skeletal abnormalities of manganese-deficient animals were related specifically to defective synthesis of mucopolysaccharides at a critical time in the development of these organisms.[11] It has also been found that manganese plays an impor-

. . . certain organisms carry specific needs for trace minerals during development and, if these needs are not met . . . the organism can suffer . . . development alteration.

tant role in normal brain function. The electroshock thresholds of manganese-deficient animals, whether or not they were ataxic, were significantly lower than those of normal controls.[12] The role of manganese in brain function may be related to the depressed incorporation of sulfur into sulfur-containing mucopolysaccharides.[13] In support of this concept, it has been found that in manganese-deficient mice at 30 days of age, incorporation of radioactive sulfur was lower than that of controls in the kidney, liver, pons, and an area of the brain analogous to the substantia nigra (the structure in the brain that becomes depigmented in patients with parkinsonism). Rats who have a tendency toward manganese-induced deficiencies, given injections of L-dopa, demonstrated lower levels of dopa and dopamine in their brains than did the controls. Similar effects occurred when tryptophan, the precursor to serotonin, was injected and serotonin was measured in the brain. However, with a large amount of tryptophan, the brain serotonin levels were normal.[14] Possibly, these organisms carried a biochemical need for manganese, which was far greater than that for normal control organisms, and without this extra margin of manganese, these organisms suffered a significant developmental and behavioral dysfunction.

Cotzias and colleagues[15] have suggested that the implications of these studies may provide a model for genetic variations among patients with parkinsonism or chronic manganese poisoning.

Copper

A similar case may be made for the element copper in certain strains of organisms. A mutant mouse termed "crinkled" shows some phenotypic characteristics of copper-deficient animals. Like humans who are copper deficient, it has increased mortality in early life, thin skin with small number of hair follicles, and abnormal texture of the hair, reminiscent of the "steely" wool of copper-deficient sheep.[16] When female carriers of this mutant gene were given a stock diet, or the purified control diet during pregnancy and lactation, only 22% to 24% of their "crinkled" offspring survived to 30 days of age. In contrast, in the mutants whose mothers were fed a high copper diet, 50% survived to 30 days of age. Therefore, the high copper feeding had prevented the delay in pigmentation characteristic of the mutant. It is implied from this study that certain organisms carry specific needs for trace minerals during development and, if these needs are not met, based on their biochemical uniqueness the organisms can suffer some untoward development alteration. In copper-deficient sheep, demyelination of the brain is a marked effect.[17] The explanation for these results appears to be heavily weighted toward the conclusion that amelioration of the mutant gene effects by copper supplementation is a result of some interaction between the gene and copper in a critical phase of development.

Zinc

Another example of the interaction between genetic factors and trace elements occurs with the element zinc. Maternal dietary zinc deficiency results in a high incidence of congenital malformations of many types including cleft lip and cleft palate in animals.[18, 19] This may have significant repercussions. Hambidge and associates[20] have reported zinc deficiency in children, and Sandstead[21] has calculated dietary intake of zinc in American diets under various conditions. Sandstead concluded that zinc nutrition of many Americans may be marginal. Marginal levels of zinc deficiency, in combination with genetic factors, may provoke malformations or other abnormalities of development in humans.[22] The report of malformed infants from women with acrodermatitis enteropathica, a genetic disease involving zinc metabolism, suggests that zinc deficiency is teratogenic in humans.[23]

Environmental Influences

In a recent review by Wilson[24] an estimate has been advanced to causes of development defects in humans. Twenty percent of these are known to be of genetic transmission, and a small proportion are caused by chromosomal aberrations or environmental causes such as infection, drugs, and so on; 65% to 70% are of unknown causation. It seems possible that nutritional factors may be involved in these abnormalities of unknown causation."[25]

There are large regional differences in the incidence of congenital malformations of the central nervous system in the British Isles, particularly South Wales.[26]

Penrose in 1957 was the first to make the suggestion: "The geographical variations observed in the incidence of anencephalus might suggest . . . a causal agent such as the presence or absence of trace elements in the water supply."[27] Fedrick[28] found no correlation between anencephaly in ten areas of the United Kingdom between the total hardness, pH, and to some extent the sodium content of the local water supply. Recently, Morton and associates[29] looked at the concentration of 20 trace elements in tap water from 48 local areas in South Wales. Associations between 12 trace elements and central nervous system malformation rates for the 48 areas were examined. Significant correlations for four trace elements were observed. Of these, aluminum was positively correlated, whereas the remaining three—calcium, barium, and copper—were found to have negative correlations with neural tube defects. Regression analysis of the data suggest the relationship between barium and copper with central nervous system malformation rates were more important than those of aluminum and calcium. It was of interest in this study that elements that attracted particular attention from animal teratologists were not shown to be correlated with central nervous system malformation rates. The authors suggest that valuable data may be obtained by measuring trace element status of blood of women in the first trimester of pregnancy and by correlating this information with malformation rates. It is shown that understanding of the role trace elements play in proper development is still new and will grow with more research.

Much information has been accumulated at the molecular level. Metal ions have the ability to react with a variety of electron donor sites on polynucleotides, as well as to provide optimal conditions for the RNA polymerase enzyme, which is the rate-controlling enzyme in protein synthesis.[30, 31] Certain metals, due to their interaction in an adverse way with the DNA molecule, have been identified as potential environmental carcinogens, through occupational exposure and in the laboratory.[32] Metal ions and mutagens in this category have been shown to inhibit and decrease the fidelity of DNA synthesis in vitro.[33] Five metal salts—lead, cadmium, cobalt, copper, and manganese—which are neither mutagenic nor carcinogenic, have been shown to decrease the fidelity of DNA synthesis in vitro, stimulating chain initiation of RNA synthesis at concentrations that inhibit overall DNA synthesis.[34] In contrast, other metal salts—zinc, magnesium, lithium, sodium, and potassium (which were not in the category of producing mutagenicity or carcinogencity)—were found to inhibit chain initiation of RNA synthesis at concentrations that inhibit overall RNA synthesis. Of the elements investigated, lead had the most significant influence on RNA synthesis, and on overall protein synthesis, followed by cadmium, and copper, respectively. Alterations in RNA synthesis rates observed in this study potentially account for some of the mutagenic and teratogenic effects observed in animal feeding studies with specific elements at high levels.

It is clear that trace element nutrition can have two influences on development. During times of selective essential trace mineral deficiencies there can be a critical alteration in a temporal sequence of biochemical events leading to inappropriate development. Secondly, it is possible that certain mutagenic or carcinogenic elements of the toxic mineral family or excessive levels of exposure to essential trace minerals can alter the development pattern by direct action on DNA or on some other aspect of the transcriptional process.

Aluminum

There has been considerable understanding of the influence toxic metal body burden or potential mutagenic trace minerals have on development and physiologic function. Aluminum has historically been regarded as nonessential and nontoxic.[35] Environmental exposure is virtually universal, since aluminum constitutes a substantial part of the earth's crust and is commonly found in food, medicine, and cosmetics. Aluminum toxicity has been observed, following direct application of aluminum salts to cerebral tissues,[36] and there have been increasing reports of aluminum toxicity from environmental exposure. An aluminum ball mill operator with progressive encephalopathy was found to have brain aluminum concentrations 20 times normal.[37] High concentrations of aluminum in the brain have also been demonstrated in Alzheimer's disease[38] and in patients on long-term hemodialysis. A recent study done in experimental animals has suggested that gastrointestinal aluminum absorption and tissue distribution are altered by parathyroid hormones. The ingestion of aluminum salts results in tissue concentrations of aluminum similar to those observed in dialysis patients with fatal encephalopathy. In dialysis patients, serum aluminum and endogenous parathyroid hormone concentrations are significantly correlated. Dialysis patients are treated with large quantities of aluminum hydroxide phosphate binding gels, and have abundant exposure to aluminum. These readily available gels are given to dialysis patients to ameliorate phosphate retention and are presumably excreted in the feces as insoluble aluminum phosphate. The work of Mayor and associates indicates that, among dialysis patients, exogenous aluminum coming from aluminum-containing antacids in the presence of severely elevated parathyroid hormone levels can result in increased gastrointestinal absorption and altered tissue distribution of aluminum. The significant correlation of serum parathyroid hormone and aluminum in humans suggests that both Alzheimer's disease and dialysis encephalopathy may be explained in part by parathyroid hormone acting on orally ingested aluminum. This is further confirmed in a recent study where brain aluminum concentrations were found to be significantly higher in seven patients dying with dialysis encephalopathy than in 11 dialyzed controls, and in two uremic patients who were not dialyzed. The association of the dialysis and encephalopathy with high levels of aluminum in the brain and in the dialysis water emphasizes the potential neurotoxicity of aluminum in humans and the need for greater sensitivity to this problem. In patients maintained on a regular hemodialysis unit, development of osteomalacia was observed, which was significantly reduced when water used to prepare the dialysate was deionized. Patients receiving softened water who had encephalopathy or dementia had serum aluminum concentrations similar to patients using the same water supply without symptoms of these diseases. "The evidence that aluminum absorption from dialysate causes osteomalacia and encephalopathy is strong enough to justify the expense of treating water by de-ionization, reverse osmosis, or both in centers where tap water aluminum is high."

Lead

There is similar concern about environmental lead. Lead tightly binds to nucleic acid material and can interrupt protein synthesis at very low levels. It may also have a variety of other adverse metabolic influences on enzyme function at reasonably low parts per million levels. Saturnine gout has been found to be related to lead toxicity. Farkas and associates have found the enzyme guanine amino hydrolase (guanase), which catalyzes the hydrolytic deamination of guanine to xanthine to nucleic acid-based materials, was sensitive to lead contamination. Guanine is a highly insoluble purine nucleic acid and its inappropriate metabolism would lead to deposition of guan-

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ine crystals, which may cause saturnine gout. The enzyme guanase is inhibited to the extent of 88% at 10 parts per million lead. By comparison, the enzyme xanthine oxidase was not inhibited by lead when tested in concentrations up to 40 parts per million. It was suggested by the authors that it is possible that meat products from animals in which guanine crystals have been observed were from animals suffering from lead poisoning, possibly due to ingestion of lead-based paint.

Inorganic lead compounds are poorly absorbed into the body from the gastrointestinal tract. Repetitive ingestion of small amounts of lead is usually far more hazardous than single massive exposures. Plumbism, thus, results from the accumulation of an excessive body burden of lead, both by ingested and inhaled routes, over a period of weeks, months, or even years. Lead from lead-based paint is now known to be one of several significant sources of lead in the environment which may lead to increased body burden. Dust and dirt may constitute intermediate dose sources of lead when contaminated by lead-based paint from interior or exterior surfaces, or automobile exhaust. Smelter dust may be a source of excessive lead burden in localized instances. There are also a number of other sources of lead, such as printed paper and canned foods. A variable percentage of ingested lead, 5% to 10% in adults, but probably more in young children, is rapidly absorbed into the blood stream. Respiratory absorption of lead is dependent on particle size, but it is generally more complete than intestinal tract absorption. If lead uptake is not excessive, it is largely excreted in the urine, bile, and sweat. If lead continues to be absorbed for a period of time at unusually high rates, tissue levels increase and result in toxic effects on soft tissues, significantly bone marrow, kidneys, and brain, and deposition of large amounts of lead in bone.[46,47] A recent report has indicated that lead intoxication through herbal medicants or possible bone meal preparations can also contribute to excessive body burden.[48] A 59-year-old woman was admitted to the hospital experiencing diffuse pain and anemia. She was found to have a 24-hour urinary lead level of 1,044 μg (normal laboratory value: 0 to 80 μg). Analysis of the spouse's blood and urine showed normal hematologic and lead measurements. She was found to have a hematocrit of 26%, and five to ten cells with basophyllic stippling per high-power field. The source of lead in this woman's environment was ingestion of brick-red, spherical, 3 mm in diameter Chinese herbal pills, which showed a lead content of 0.5 mg/pill. At 30 pills per day, the patient was ingesting up to 15 mg of elemental lead daily. The lead-induced anemia, which was of the microcytic, hypochromic type, has been shown to be a result of an interference with the metabolism of copper and iron, as well as the complete synthesis of porphyrin from δ-aminolevulinic acid. In this complex interaction, copper may be the target on which ingested lead has an antagonistic effect on hematopoiesis. The depressions in hematocrit and hemoglobin levels from exposure to lead may occur secondarily to the effects of lead-induced copper deficiency on iron mobilization and utilization. The metabolic fault induced by lead is seen in a reduction of serum iron, elevation of serum iron binding capacity, and increase in liver iron, all manifestations of systemic defects related to the interference with copper metabolism.[49] Levander[50] has shown that deficiency of selective micronutrients and macronutrients and imbalances of other trace minerals can enhance heavy metal toxic, teratogenic, or mutagenic influences. Vitamin E deficiency renders animals more susceptible to the toxic effects of lead,[51] and the resistance of red blood cells from vitamin E-deficient, lead-poisoned rats to an oxygen trauma with much less than those of the red cells from vitamin E-adequate lead-poisoned animals. In another example,[52] the protective effect of selenium against the toxicity of mercury has been clearly demonstrated in short-term acute toxicity studies, in which inorganic salts of both elements were administered via injection.[52] This protective action led the author to suggest that one of the biological functions of selenium as a nutritionally essential trace element "could be the protection of the organism against the toxicity of trace amounts of metals that even under normal conditions enter the body from the environment and remain." Such a hypothesis proved prophetic when Ganther and associates[53] showed in succeeding experiments that nutritional levels of selenium could decrease the chronic toxicity of methyl mercury. These findings lead to the concept that selenium in tuna may provide a built-in protective mechanism against methyl mercury poisoning.[54]

In conclusion, it can be seen that trace elements have significant influences in development and cellular replication, both in utero and post utero. Certain elements in narrow concentration ranges promote proper development, whereas other elements seem to interfere with the development process, or even initiate mutagenesis or teratogenesis. The emerging sensitivity to biochemical uniqueness of the organism should allow better patterning of the maternal needs of specific trace elements for optimal gestational mineral exposures. As was suggested almost 50 years ago by the work of Weston Price, trace minerals may prove to be a significant contributor to preventing untoward development changes. Exposures to lead, cadmium, and excessive copper in the environment may induce untoward metabolic consequences and alter development, as well as cell replication. This fact may be promoted or ameliorated by the presence or absence of other minerals and nutrients. Our concern for agents that were previously considered completely nontoxic, such as aluminum, demonstrate the heightened sense of awareness within the medical community to the adverse influences that many of the trace mineral agents may have on physiologic function and development. It is hoped that research will help the clinician pattern the maternal environment appropriately with regard to the trace minerals to promote optimal development of the fetus. It is not the sole explanation for the defect of sodium transport seen in uremia.

Periodontal Disease and Mineral Status

It should be noted that a common form of degenerative disease in our culture today, periodontal disease, may have some relationship to mineral status. A periodontal index based on visual and roentgenographic data was used to evaluate 80 dental patients; their periodontal index scores were correlated to serum concentrations of calcium, copper, iron, magnesium, manganese, and zinc. Regression of the periodontal index on the serum mineral constituents demonstrated that serum copper was linearly related to the index. Whether this evaluation in copper is due to the influence of inflammation, which is characteristic of periodontal disease, or related to the cause of the disease, has not been confirmed, but raises some question as to the relationship between trace mineral nutriture and periodontal disease.[55]

It is concluded that trace mineral nutriture in community medicine plays a significant role in establishing both appropriate and potentially inappropriate physiologic function. In the case of total parenteral nutrition, it can be seen that many potential medical problems may have existed as a result of practitioners being insensitive to trace mineral deficiency problems. As we learn more about the implications of trace mineral nutriture on optimization of human health and the deficiency symptoms that result from suboptimal mineral nutrition, the applications of these concepts will be better accepted and understood. Until that time, however, it should be clear that a conservative approach toward handling a patient would be to provide an appropriate margin of protection to ensure meeting the trace mineral nutriture needs of that particular patient, either prophylactically or therapeutically, on a daily basis. □

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Statement on Radium in Drinking Water

Submitted by Dr. R. E. Rowland

The Safe Drinking Water Act of 1974, Public Law 93-523, authorized the Environmental Protection Agency to establish Federal standards for protection from all harmful contaminants and for protecting underground sources of drinking water. This statement examines the levels set for radium in drinking water, and demonstrates that, on the basis of new metabolic data, these levels are unrealistically low. Specifically, under Title 40 of the U. S. Environmental Protection Agency's National Interim Primary Drinking Water Regulations, paragraph 141.15, a combined level of 5 pCi/liter is set for ^{226}Ra and ^{228}Ra. It will be shown below that the justification for a level of 5 pCi/l has been found, by the organizations formed to advise on radiological protection, to be in error. These organizations have recognized the error and are in the process of altering their recommendations. Since the EPA's enforcement of this erroneous level is causing unnecessary financial problems for community water systems, it is proposed that the levels for radium in drinking water be revised so as to provide the margin of safety they were originally designed to provide.

While radium in drinking water supplies is not normally the consequence of activities of the nuclear industry, nevertheless the guidance issued for such activities by the International Commission on Radiological Protection (ICRP) or the National Council on Radiation Protection and Measurement (NCRP) is usually considered to be relevant for naturally occurring radioisotopes in water. Throughout the history of these organizations they have suggested that dose limitations for the general public be lower than those for workers in the nuclear industry. Factors of 1/3, 1/10, and 1/30 have been suggested at various times as appropriate reductions to be applied to the levels derived for workers in nuclear industries to make them applicable to the public at large.

A summary of the various values of the maximum permissible concentration in drinking water (MPC_w) for radium indicates that the suggested levels have remained fairly stable over the past 25 years, and that the values adopted in 1974 by the EPA were similar to the values recommended by the two major protection organizations, the ICRP and the NCRP. For example, in 1959 the ICRP, in its Publication 2, Report of Committee II on Permissible Dose for Internal Radiation, made the following statement.

> Paragraph (68). "In view of the existing uncertainty as to the dose-effect relationships for somatic effects, it is suggested that for planning purposes the average concentrations of such isotopes that concentrate in specific organs (other than the gonads), or mixtures thereof, in air or water, applicable to the population at large, should not exceed one-thirtieth of the MPC values for continuous occupational exposure given in the report of Committee II."

Table 1. Maximum Permissible...Concentrations of Radionuclides...in Water for Occupational Exposure

$_{88}Ra^{226}$	soluble	10^{-7} μCi/cm^3 for 168-hour week
	insoluble	3 x 10^{-4} μCi/cm^3 for 168-hour week
$_{88}Ra^{228}$	soluble	3 x 10^{-7} μCi/cm^3 for 168-hour week
	insoluble	3 x 10^{-4} μCi/cm^3 for 168-hour week

Applying the suggested factor of one-thirtieth, these values yield limits for radium in water for the population at large of 3 pCi/l for ^{226}Ra and 10 pCi/l for ^{228}Ra.

Radium, when taken into the human body, does not remain there for as long a time period as the simple models employed by the ICRP and the NCRP suggest. This fact has long been known to these organizations, but only recently has there been a definitive model designed to describe the retention of radium in the human body over long periods of time. The ICRP has already acted to change its standards for radium on the basis of this definitive model.

The Safe Drinking Water Act of 1974 required the Administrator of the Environmental Protection Agency to enter into an appropriate arrangement with the National Academy of Science (NAS) to conduct a study of the potentially harmful effects that impurities in water might have on the health of those who drank it. The Administrator was to make prompt use of the NAS findings as the scientific basis for revision or verification of the Interim Primary Drinking Regulations that were promulgated under the Act.

The requested study was published in 1977 under the title Drinking Water and Health. It contained a relevant chapter on Radioactivity in Drinking Water. In this chapter it was clearly pointed out that the model for radium retention used by the ICRP (and by implication, the NCRP) was not valid. As a consequence, the retention of radium after 50 years of continuous intake was actually more than a factor of 10 lower than the model previously used predicted. The following quotation from the NAS report clearly identifies the problem.

> "In its 1959 report on permissible doses (ICRP Publication 2), Committee II of the ICRP used an exponential model of retention for all radionuclides to calculate maximum permissible concentrations in water. The ICRP committee pointed out, however, that there was good evidence that retention of radium-226 and other bone-seeking radionuclides is best represented by a power function model (Norris et al., 1958). In the case of radium-226, the calculated body burden from intake at constant daily rate for 50 yr is about a factor of 10 smaller by the power function model than by the ICRP exponential model...
>
> "Since 1959, additional data have tended to support a power-function model for bone seekers. In 1972, a task group of Committee II of the ICRP presented a detailed model of alkaline earth metabolism (ICRP Publication 20, 1973). For a constant rate of intake into the blood for 50 yr, the newer model predicts a whole-body content that is only 5% less than the simple power function given above.

> "Measurements of radium-226 body burdens and dietary intake at environmental levels also indicate that the ICRP exponential model predicts long-term retentions that are too high..."

It was the adoption by the ICRP of the report issued in 1973, ICRP Publication 20, that provided the necessary documented scientific background to clearly define the retention of radium by the human body at long times after acquisition. It is the facts, and the resulting model, published in ICRP Publication 20, that provide the basis for the new, increased limits of intake for radium. The ICRP report does not imply that the risks from retained radium are lower. Rather, it demonstrated that the retention of radium was lower, and therefore that more radium could be ingested without increasing the risk. The NAS study, for the EPA, recognized and identified the problem, but the EPA did not act on this advice. As a consequence, the limits for radium in drinking water as published in the Safe Drinking Water Act of 1974 remained unreasonably low.

The International Commission on Radiological Protection (ICRP) has now issued new recommendations for the values of the Annual Limits of Intake (ALI) of radionuclides for workers in nuclear industries. The first publication of these recommendations appeared in ICRP Publication 30, Limits for Intake of Radionuclides by Workers (Annals of the ICRP, Vol. 2, No. 3/4). From the ALIs for the significant isotopes of radium, ^{226}Ra and ^{228}Ra, limits for the level of these radionuclides in drinking water can be derived. Historically, such levels have been reduced to obtain appropriate levels of radium in drinking water for the general public. The levels so obtained will be markedly higher than those previously published by the ICRP, and will be higher than the present levels for drinking water as defined in the Safe Drinking Water Act of 1974 (PL 93-523), and published under Title 40 of the U. S. Environmental Protection Agency's National Interim Primary Drinking Water Regulations.

In ICRP Publication 30, the Annual Limits of Intake for the two radium isotopes of interest are:

^{226}Ra : 7×10^4 Becquerel (Bq) or 1.9 µCi

^{228}Ra : 9×10^4 Bq or 2.4 µCi

A maximum permissible concentration in water (MPC_w) for nuclear workers can be calculated by assuming 2 liters of water per day are ingested, and that water is the principal source of ingested radium.

$$(MPC_w \text{ for } {}^{226}\text{Ra in Ci/l}) \times (2\ \frac{\text{liters}}{\text{day}}) \times (365\ \frac{\text{days}}{\text{year}}) = 1.9\ \mu\text{Ci}$$

$$(MPC_w \text{ for } {}^{228}\text{Ra in Ci/l}) \times (2\ \frac{\text{liters}}{\text{day}}) \times (365\ \frac{\text{days}}{\text{year}}) = 2.4\ \mu\text{Ci}$$

or $^{226}\text{Ra } MPC_w = 2.6$ nCi/liter

$^{228}\text{Ra } MPC_w = 3.3$ nCi/liter

If the largest reduction factor previously employed, 30, to reduce occupational levels so as to make them applicable to the public at large is now applied to these new levels, they become 87 pCi ^{226}Ra/liter and 110 pCi ^{228}Ra/liter. Even a 100-fold reduction, 26 pCi ^{226}Ra/liter and 33 pCi ^{228}Ra/liter, results in levels significantly higher than the EPA standard of 5 pCi/liter.

How did the EPA arrive at the level of 5 pCi ^{226}Ra/liter of drinking water? From a document entitled "Statement of Basis and Purpose for the Proposed National Interim Primary Drinking Water Regulations," USEPA, August 15, 1975, a basis for the limits of radioactivity in drinking water can be determined.

For radium the ingestion limit was based on studies of the uptake of radium, and on a limit of 20 pCi per day previously proposed by the Federal Radiation Council. Under the assumption that the ultimate skeletal body content is 50 times the total daily intake of ^{226}Ra, it was stated that this limit would result in a burden of 1000 pCi. The proposed limit of 5 pCi ^{226}Ra per liter of water would thus ultimately result in a body content from water of 500 pCi, which was stated to deliver a (bone) dose of 150 mrem per year.

Unfortunately, these assumptions are not correct. Table VII-2 of the NAS report gives values of the ultimate dose achieved after 50 years of drinking water containing 1 pCi/liter of various radioisotopes. For ^{226}Ra and daughters, and for ^{228}Ra and daughters, the dose to bone after 50 years is listed as 16 mrem per year. At the EPA limit of 5 pCi radium/liter, the bone dose would rise to 80 mrem per year after 50 years of ingestion. At this intake the NAS report shows the body content would reach 370 pCi (not 500 pCi) after 50 years.

Before suggesting any changes in the current limit for radium in drinking water, it is appropriate to ask if there is evidence for effects of radium at levels as low as 5 pCi/liter. In the Federal Register 41,133, pp. 28402-405 (1976), the regulations for radioactivity in water were promulgated in final form by the Environmental Protection Agency. In the justification for the published levels for radium (in the section entitled Maximum Contaminant Level for Radium), mention is made of a U. S. Public Health Service study of the effects of elevated radium levels in public water supplies.

It is unfortunate that this study (An Epidemiologic Approach to Low-Level Radium 226 Exposure, Public Health Reports, Vol. 81, No. 9, September 1966) was used as a justification of radium water levels, for it does not provide a valid measure of risk of radium in water systems. This report purports to show that a population group exposed to a mean drinking water concentration of 4.7 pCi ^{226}Ra per liter had an adjusted bone neoplasm mortality rate of 1.41 deaths per 100,000 compared with a rate of 1.14 in a control population, and quoted a P-value = 0.08.

No mention is made of the fact that the authors of the study prepared an Interim Report for evaluation by an expert review group. (A copy of this Interim Report was obtained from the EPA Region V Library, 1 North Wacker Drive, Chicago.) This evaluation took place on October 6-7, 1964. The interim report examined deaths attributed to "sarcoma" or "Ewings tumor"; it concluded that "no significant difference could be detected between the osteosarcoma mortality rate in towns with water supplies having elevated levels of Ra-226 and matched control towns with water supplies having negligible levels of Ra-226."

Examination of the data supplied in the tables accompanying the 29-page Interim Report shows clearly the basis for the above conclusion. The following entries are taken from Tables 7 and 9 of the Interim Report.

Exposure category	Osteosarcoma mortality, 1950-1962: age- and sex-adjusted mortality rates. Deaths per million man-years
Chicago (Table 7)	5.6
Elevated Ra-226 Towns (Table 9)	5.5
Control Towns (Table 9)	4.9
Probability of Difference (Elevated vs. Control) Occurring by Chance (Table 9)	56%

It should be noted that Chicago's water supply is drawn from Lake Michigan, in which the radium concentration is very low.

Shortly after the "expert review," the results of the study were published in the Public Health Reports, and it is these results that are quoted in the Federal Register. However, while in the interim report the authors had used only deaths attributed to "sarcoma" or "Ewings tumor," the published report used deaths coded to malignant neoplasm involving bone, identified as international code number 196. This is a significant change, and somewhat surprising in view of this statement made to the reviewers by the senior author. (An edited transcript of the meeting was made available to those present; the following quotation appears in that transcript.)

> "Information on the death certificate was used for determining whether a case of bone cancer was a case of osteosarcoma. The 1958 NOVS-Argonne study demonstrated that of all bone cancer cases coded to code 196 only 35% could be pathologically confirmed as osteogenic sarcoma. About 1/3 of the bone cancer cases involved the jaw. I have been told that pathologists believe that cancer of the jaw is not osteogenic sarcoma, and is usually a buccal cancer. Also one-third of all bone cancers were soft tissue cancers which had localized in the bone and could not be confirmed as osteogenic sarcoma. The 1958 study also showed with 90% confidence that the words "sarcoma of a bone" on a death certificate was a good indicator of whether the death was indeed due to osteogenic sarcoma..."

It appears that, with the decision made that the study was to be terminated, the results of the interim study were published with a poor measure of bone sarcoma occurrence, perhaps in order to achieve a result that appeared to be significant. Mention is made in the published report of the high bone neoplasm mortality rate in Chicago, which "...exceeded the rate in the control population, even though Chicago is served by a surface water supply having only 0.03 pCi of radium 226 per liter." No mention is made of the fact that the Chicago rate also exceeded the rate in the elevated drinking water regions.

I conclude that the Public Health Service study did not demonstrate a relationship between elevated radium levels and malignant bone tumors induced by radium; my conclusion is supported by the Interim Report of that study, which examined the data with more rigorous standards.

It is not surprising that no effects were seen. Since that time a number of reviews of the effects of low-level radiation have been published, as has a major study of the effects of internally deposited radium in female dial workers. Each of these reviews and studies produced risk estimates, which, when extrapolated to the very low doses represented by radium in drinking water, predict lower malignancy rates than purported to have been observed in the Public Health Service study.

Conclusion

The acceptance by the ICRP of the data acquired over the past 50 years on the metabolism of radium in humans, and its use in formulating the Annual Limit of Intake for the radium isotopes, results in a derived MPC_w far greater than previously proposed. Even reducing this MPC_w, derived for those occupationally exposed, by a factor as large as 100 would result in a level for the general public of 26 pCi ^{226}Ra/liter and of 33 pCi ^{228}Ra/liter. It is respectfully suggested that the levels for radium in drinking water supplies ought to reflect the considered opinion of the members of this organization.

A combined level of 30 pCi/liter for ^{226}Ra and ^{228}Ra appears to be justified. Adoption of such a level would save many millions of dollars annually, which are now required to achieve conformity with the law, and which provide no equivalent benefit, for it is spent to eliminate a nonexistent hazard.

APPENDIX 2

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PERMANENT SELECT COMMITTEE
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February 19, 1980

QUESTIONS FOR THE RESPONSE OF DR. STEPHEN GAGE OF THE U. S. E.P.A.

With regard to studies related to the barium and radium standards in community drinking water supplies:

1. What studies were used as the basis for establishing the original standards for barium and radium in community drinking water supplies? What measures did EPA take to insure that the results of these studies were indeed valid? Were these studies subjected to external peer review? If so, what was the result and how did you act on them? If not, will this be done?

2. After EPA established their standards for barium and radium in drinking water, was any effort made to reevaluate the scientific studies on which these standards were based to insure their accuracy and validity? If so, what was done and what was the result? Does EPA feel these standards are currently valid? Why? Will EPA conduct new studies on the health effects of barium and radium for the purpose of standard setting? If not, why not? How much funding would such a study require?

3. Will you authorize studies to be conducted at West Dundee, Illinois, where barium has been present in the water supplies for a period of approximately 25 years, and where scientific studies could be conducted utilizing water containing barium and other elements combined naturally in the water supplies rather than barium in distilled water, and where epidemiological studies could be conducted and targeted specifically to people who have been drinking this water containing approximately 8 mg/l barium for the past 25 years? If not, why not?

4. Will you authorize similar studies to be conducted in St. Charles, Illinois, where small amounts of radium are naturally present in the water supply of that community? If not, why not?

5. Will you seek a proposal for studies from the Argonne National Laboratory, Argonne, Illinois, which is in close proximity to the affected communities in Illinois and which is already uniquely equipped to conduct such studies? If not, why not?

6. Do you recommend that there should be more studies regarding barium and radium standards for community drinking water supplies? Explain your reasoning.

7. If the answer to 6. above is affirmative, do you recommend that the imposition of penalties against communities whose water supplies exceed the present standards for barium and radium be deferred until further studies result in more valid scientific data for the promulgation of new standards?

Robert McClory

EPA RESPONSE

1. What studies were used as the basis for establishing the original standards for barium and radium in community drinking water supplies? What measures did EPA take to insure that the results of these studies were indeed valid? Were these studies subjected to external peer review? If so, what was the result and how did you act on them? If not, will this be done?

As the Safe Drinking Water Act directed, the interim primary regulations were based on the 1962 PHS Drinking Water Standards, as reviewed and updated by the EPA Advisory Committee on the revision and application of the Drinking Water Standards. Prior to the review of the Standards by the Advisory Committee, the Standards were also reviewed by a Technical Task Force. The proposed regulations were further reviewed by the National Drinking Water Advisory Council, in addition to review by other Federal agencies, State and local government agencies, a Work Group which included representatives of public interest groups, as well as the general public. After promulgation the National Academy of Sciences also reviewed the bases for all of the individual MCLs in their 1977 report "Drinking Water and Health." The result of all these reviews is that the basis for the MCLs for barium and radium were accepted, and the MCLs were unchanged while some further studies were recommended.

The Canadian Maximum Acceptable Concentration for barium in drinking water is also one mg/l. In addition they have a recommended objective level of 0.1 mg/l. The European Communities (EEC) guide level for barium is also 0.1 mg/l. Radionuclides, including radium, are proven human cancer causing agents. The objective of any standard is to reduce human exposure to protect human health to the extent that is technically and economically feasible.

2. After EPA established their standards for barium and radium in drinking water, was any effort made to reevaluate the scientific studies on which these standards were based to insure their accuracy and validity? If so, what was done and what was the result? Does EPA feel these standards are currently valid? Why? Will EPA conduct new studies on the health effects of barium and radium for the purpose of standard setting? If no, why not? How much funding would such a study require?

As noted in the response to Question No. 1, all MCLs and their scientific bases were reevaluated by the National Academy of Sciences as provided in the Safe Drinking Water Act. Also as noted earlier, the result was that the MCLs were unchanged. EPA feels, on the basis of the many reviews, and the absence of evidence to the contrary, that these MCLs are currently valid. Nevertheless, EPA has and is conducting additional studies on the health effects of many contaminants, to provide further substantiation for the MCLs, to verify new information where such has been reported, and to prepare for revised primary drinking water regulations.

An epidemiological investigation was conducted in several communities in Illinois. Subchronic toxicology studies on rats were conducted. Two additional animal studies are underway involving metals including barium and cardiovascular disease effects. New studies being considered include additional epidemiological studies, and clinical studies evaluating blood levels of barium and potassium in persons exposed to barium in water, and barium levels in children's teeth.

The cancer causing effect of radium is well known. We are considering whether or not any epidemiological studies on populations exposed to high levels of radionuclides would provide any useful information, given the complexities and costs of such studies.

3. Will you authorize studies to be conducted in West Dundee, Illinois, where barium has been present in the water supplies for a period of approximately 25 years, and where scientific studies could be conducted utilizing water containing barium and other elements combined naturally in the water supplies rather than barium in distilled water, and where epidemiological studies could be conducted and targeted specifically to people who have been drinking this water containing approximately 8 mg/l for the past 25 years? If not, why not?

EPA authorizes studies that include scientifically valid programs that are relevant to our information needs and within budgetary constraints. The initial epidemiological study referred to in Question 2 was conducted in West Dundee. Whether another epidemiological study would be conducted in West Dundee depends on many factors, such as the population, the use of water softeners, and the existence of a qualified control community. These questions would best be answered by an epidemiologist after further study of West Dundee and other potential sites.

4. Will you authorize similar studies to be conducted in St. Charles, Illinois, where small amounts of radium are naturally present in the water supply of that community? If not, why not?

Whether a contaminant is of natural or other origin does not change the health risk. Whether or not an epidemiological study would be possible is dependent on many factors including whether the relative risk would be amenable to detection by the limited sensitivity of these types of studies.

5. Will you seek a proposal for studies from the Argonne National Laboratory, Argonne, Illinois, which is in close proximity to the affected communities in Illinois and which is already uniquely equipped to conduct such studies? If not, why not?

Proposals submitted to EPA are subject to evaluation on several bases. If a proposal is submitted by Argonne National Laboratory, it will be evaluated along with all other similar proposals. Grants or contracts are awarded for proposals having the greatest merit and involving personnel with the best available expertise and interest in the subject matter.

6. Do you recommend that there should be more studies regarding barium and radium standards for community drinking water supplies? Explain your reasoning.

It can be said that there are never enough studies on any given topic, and for this reason further studies on barium would be welcome. Since the hazards of radioactivity, from radium or other sources, are quite well defined it is not clear whether epidemiological studies on populations exposed to radium or other radionuclides in their drinking water would be fruitful. This possibility is being considered.

7. If the answer to 6. above is affirmative, do you recommend that the imposition of penalties against communities whose water supplies exceed the present standards for barium and radium be deferred until further studies result in move valid scientific data for the promulgation of new standards?

To defer enforcement of drinking water regulations would essentially invalidate the Safe Drinking Water Act and the extensive historical effort from which the standards were developed. The MCLs for barium and radioactivity, among other contaminants, are essentially the same as the limits in the 1962 PHS Drinking Water Standards, in effect since 1962 and later recommendations of scientific bodies. The MCLs have been subjected to intensive review, and have withstood such review. These standards are quite consistent with other existing national and international standards. While there is always the possibility of new data being generated, to continually wait for this new data means continual exposure to the people in those communities to substandard adulterated water. The Safe Drinking Water Act provides for enforceable interim regulations pending the development of revised regulations. We believe the prescribed procession of regulations should be followed, and that the interim regulations be enforced pending discovery of substantial new data that would warrant a change. Exemptions are provided in the Safe Drinking Water Act to provide more time for communities that are having difficulty achieving compliance. In the meantime we are reevaluating all standards for future iterations.

APPENDIX 3

Summary of Issues Related to Heavy-Duty Diesel Engine Emission Standards

I. Costs of Compliance

As part of the rulemaking process, EPA has made extensive assessments of the costs of compliance. EPA used the best information available, including information submitted by the manufacturers. In many cases, EPA had to develop its own estimates since manufacturers did not provide any information.

The results of EPA's assessments indicate that diesel engine manufacturers will have to raise the price for diesel engines by $108 to $519, with the higher increases for manufacturers with low U.S. sales. It should be emphasized that this cost analysis has assumed the worst case (i.e., higher costs) for small volume manufacturers. Therefore, the cost figures will probably exceed the actual cost increases for these manufacturers. The spread in the estimates is considerable, and in a few cases represents a sizable fraction of total engine cost. It should be noted, however, that the manufacturers with the highest increases produce heavy-duty diesel engines for use in motor vehicles sold in the U.S. as only one small part of their large, and often multinational, operations. Some presently enjoy a price advantage over the larger manufacturers, which will offset part or all of the differential in price increases. Based on corporate size, product diversification, assets, and total worldwide sales, each of the manufacturers with the larger price increases could absorb the cost of regulations without any threat to its corporate survival. Any or all could withdraw from the market without any threat to its survival and with little impact on the remaining manufacturers or on competition in the market. If any or all of the small volume manufacturers were to withdraw from the heavy-duty diesel market, engine availability would be unaffected and no significant cost increase would occur as a result of less competition. This is true because the U.S. sales market is heavily dominated by the large volume domestic producers.

EPA estimates that the price increases for these large volume manufacturers should be in the range of $108 to $177.

II. Validity of Testing for NOx

During the comment period, several commenters argued that use of a constant volume sampler (CVS) for emission sampling during the transient test was unnecessary, and in one case, technically incorrect. In a CVS system, bags are used to collect the sample, which is subsequently analyzed.

Cummins presented data which indicated that bag sampling of diesel exhaust results in NOx measurement errors. In a bag, there appears to be a 15 to 20 percent loss in measurable NOx. Resolution of this discrepancy is anticipated to be continuous heated sampling of NOx by integration. The interim NOx standard is already so lax that no difficulty in its attainment using either sampling system is anticipated.

Since the precise measurement of NOx is not a critical question in view of the lax NOx standard, EPA believes that use of either bag or continuous dilute sampling systems should be permitted for 1984. It is understood that technical problems exist in bagged NOx measurements with diesels, yet its use should be permitted in 1984 due to its minimal impact. Dilute continuous NOx measurement will be adopted as part of the forthcoming NOx standards for 1985 model year, and bag sampling of NOx will be abandoned.

Several manufacturers claimed that the 10.7 g/BHP-hr. interim NOx standard would be difficult to achieve in conjuction with the reduction in HC. EPA does not believe that there is a basis for this claim. The highest NOx observed at SWRI (an EPA contractor) on any 1979 engine has been 5.91 g/BHP-hr., only 55 percent of the proposed standard; HC emissions for this engine were below the production target. Data from Cummins was somewhat higher (due somewhat to a different measurement technique); Cummins flatly stated, however, that compliance would be no problem. Several manufactuters did comment, however, that NOx measurements at SWRI were technically suspect. Investigation of the equipment at SWRI revealed deficient water traps in the 13-mode test NOx analyzer, yet SWRI's 13-mode NOx measurements were never used for regulatory action and standard setting. The 13-mode tests were used both for assuring the operations integrity of the engine and for comparative purposes with transient tests. Errors in SWRI's 13-mode NOx measurements, therefore, have no impact whatsoever on the standard. In addition, manufacturers based their estimates on 13-mode data. The transient test procedure generates less NOx than the 13-mode. Therefore, the industry's projections are overly pessimistic.

III. Idle Test for Diesels

EPA proposed seperate certification standards and test procedures for the idle mode for both gasoline and diesel engines. The final standards retain the idle CO standard for gasoline engines, and delete the idle tests requirements for diesel engines and the idle HC standard for gasoline engines.

As part of the rulemaking process, diesel manufacturers stated that diesel engines have inherently low HC and CO idle emissions, and that required idle certification tesitng would add to testing expense with no corresponding impact on air quality. Furthermore, Cummins Engine Company submitted data showing that any diesel engine failing the idle test would certainly fail the transient test.

EPA's proposal was based on the need to provide for control of emissions while idling. A study of heavy-duty vehicle operations indicated that over 45 percent of truck operational time in the New York urban area was spent at idle. Based upon this fact, it is reasonable to presume that some degree of ambient CO problems can be attributed to idling heavy-duty vehicles. Also, high CO ambient readings are commonly found associated with congested, rush hour traffic. It is also well established that such congested traffic situations contain high percentages of idle operation.

Costs of compliance with the certification idle test are minimal. Catalysts (to be used on gasoline engines) adequate for the transient certification procedure can easily be made to meet the certification idle standard as a matter of course, requiring no additional development costs. The only costs attributable to the idle test procedure are those associated with performance of the actual test, which are insignificant on a cost per engine basis. Setting an idle CO standard for gasoline engines is clearly warranted. Diesel engines emit minimal idle emissions (today's diesels are well under the proposal idle standards), will not be equipped with emissions sensitive catalyst systems, and evidence to date indicate virtually no deterioration. Use of an idle test procedure for diesels is expected to have little or no benefit.

In summary, the high percentage of time urban trucks spend at idle, the ease of an in-use idle procedure, the relative effectiveness of an in-use idle procedure in detecting failed catalyst systems, and the virtually nonexistent costs of a certification idle standard supported its promulgation. No compelling data, however, supported implementation of any idle standard for diesel engines, and a delay in its promulgation is warranted. This decision could be reconsidered in the future should the need become more evident.

IV. Testing Equipment and Facilities

EPA has determined that both the gasoline and diesel engine manufacturers will be able to comply with the regulations by the 1984 model year. Our analysis, based substantially on information submitted by the manufacturers, shows that certification should be complete several months in advance of the beginning of the production of 1984 engines.

The design of a pre-certification timetable for diesel manufacturers differs from that of the gasoline engine makers primarily because of equipment requirements. Currently, diesel development work is done on eddy-current dynamometers (which absorb energy but lack the capability of driving (motoring) the engine). Conversion to transient control will require the replacement of these machines with electric motoring dynamometers. All of the major manufacturers have begun procurement of at least one advance test cell, but they disagree on the time required for additional development dynamometers. Caterpillar expected that construction of a new facility alone would last three years, and IH desires to postpone the acquisition of new equipment until EPA finalizes particulate standards. Yet both of these obstacles can be avoided--Caterpillar's by making efficient use of existing facilities during construction and IH's by a simple corporate decision to pursue 1984 certification. By September 1981, all manufacturers should have transient test cells operating and development will have begun.

EPA has carefully studied the various company estimates of the time required for development work. The differing amounts of work required among diesel engine families to bring them into compliance will facilitate the efficient use of cells as they become available (engines needing the most work would be placed in the earliest cells). Also, most engine families that will require work are reasonably close to the target levels already, as indicated by our technological feasibility assessment. With such factors acting in favor of the industry, 14 to 16 months of engine development work should be sufficient. Durability testing and certification stretch the process into 1983, leaving about 7 additional months before 1984 production. However, it might be possible for the diesel manufacturers to comply by 1983, especially if development efforts were accelerated.

There is a possible alternative route available to the diesel manufacturers. It may be possible that an eddy-current dynamometer could be converted to transient control. While eliminating the cost of dynamometer replacement, this option suffers from the uncertainty that the operation of such a system would sufficiently mirror that of an electric dynamometer. Thus, a system would have to be built up and proven before a manufacturer could commit to further procurement. The resulting effect on the total precertification process is a 4-month extension of the schedule outlined above. Because of this delay, we expect that few, if any manufacturers will use this option. To remove some of the risk, however, EPA will allow the option of certification on the current 13-mode procedure for one additional year (the 1984 model year). A standard which "roughly" corresponds to the transient HC standard and a separate NOx standard have been developed to minimize the loss of air quality benefits.

V. Technological Feasibility of the HC Standard

During the rulemaking process, diesel manufacturers took issue with EPA's assertion in the Draft Regulatory Analysis that no significant development work would be required to allow diesels to comply with the proposed HC standard.

EPA's final analysis indicates that greater than a third of both 1979 engines (36%) and 1979 engine families (37%) should already meet the 1984 production transient target levels (10% AQL) required to comply with Selective Enforcement Audits (SEA). Actual transient data more than substantiate this claim 72% of all diesels tested on the transient procedure exhibited levels below the standard; 44% had HC levels below the production targets.

The degree of present compliance is manufacturer specific. Cummins Engine Company is well ahead of the rest of the diesel industry in terms of emission control. Sixty percent of their engine families and 95.5 percent of their projected 1979 unit sales should meet the 10 percent AQL production target level associated with the transient HC standard. Cummins claimed that some development work was necessary on several of their families to achieve total compliance; specifically noted were efforts to develop a new technology, variable injector timing. Of the four engine families needing work, the grossest HC emitter--family 172A--has already been dropped for 1980. Furthermore, Cummins identified several control strategies in their submission to EPA and included each strategy's known effects on emissions. However, Cummins declined to submit detailed data using the explanation that "detailed data on the emissions capability of future technologies are of a proprietary nature...." EPA interprets this to mean that Cummins believes it has technological and competitive advantages over the rest of the industry; this interpretation is substantiated by Cummins' distinct predominance in the field of emission control. Cummins' major new technology, variable injector timing, has already been incorporated on at least one test engine transient HC emission data for this engine met the production target emission level. In summary, Cummins is quite close today to 100 percent compliance, has identified and is familiar with several control strategies for the future, and is capable today of transient testing and development work. Cummins has testified that their avowed corporate policy for the last several years has been to develop low emission engines; the facts substantiate this claim, and imply that a consistent application of technology can effectively reduce engine emission levels.

Caterpillar Tractor Company is a distant second in terms of HC emission control, due primarily to the high HC emissions of their high sales volume 3208 (DINA Family 3), representing 57.4 percent of Caterpillar's 1979 projected unit sales. But the current version of the Family 3 3208 incorporates little emission control technology. Nonapplication of technology in the past is by no means a persuasive argument that technology is inapplicable for the future, especially with several proven options available, one of which--EGR, has already been applied on a production basis to Family 13. Aside from the Family 3 3208, 70 percent of Caterpillar's remaining engine families are anticipated to meet the production targets. With the exceptions of Families 3 and 13, for every Caterpillar engine family which is observed to emit high HC, there is a virtually identical engine which does not. Families 3 and 13 both exceed the HC targets, while addition of EGR to the virtually identical 13 achieved a significant HC reduction. Furthermore, both engines lack turbochargers and aftercoolers, which would lower emissions. EPA cannot dispute the contention that some redesign and development work will be necessary for Caterpillar, and it is recognized that Caterpillar is in a less than optimal situation by virtue of the fact that their highest sales engine is probably their dirtiest. Yet it is also one of the least controlled engines on the market, viable technologies exist today, and four years leadtime for development is available.

International Harvester produces three diesel engine families, one of which (DTI 466B) has been tested over the proposed transient test and easily complied with the production targets. The 466B is a higher technology (i.e., intercooled) version of the DT 466 high sales volume engine, and is primarily manufactured for sale in California. The application of this additional control technology to the 466 has already been accomplished on a production basis. IHC's remaining engine, the low-sales volume 9.0 liter version, is the engine on which the greatest HC reductions will be required. It is also neither turbocharged nor intercooled, and has a number of characteristics common to high HC engines (high rated speed, low rated horsepower, very high surface/volume ratio).

Mack's product line has yet to be tested over the transient cycle, but extrapolated transient emissions predict three to five engine families will exceed both the target and the standard. Family 9 is one of these, although already turbocharged and aftercooled. Mack declined to comment on technological feasibility claiming lack of data; this lack of data also constrains this analysis. Furthermore, each of Mack's engine families are different; this precludes comparison of emissions and applied technologies between comparable engines. EPA can only draw inferences from the degree of compliance of other manufacturers, the effectiveness of control strategies as evidenced by engines on the market today, and the lack of evidence that Mack's engines are fundamentally different in some way from other diesel engines. Based upon this and the fact that two out of five of their engine families presently comply, no compelling evidence exists to indicate that Mack's engines cannot be brought into compliance given four years to do so.

Detroit Diesel Allison (DDA) is the only major diesel manufacturer whose entire product line exceeds the HC target levels. Particularly dirty are those engine families which are naturally aspirated. Detroit Diesel has indicated that families 4L-53T, 8V-71NC, 6L-71N, 8V-71N, and 6V-71NC will not be produced after 1982, however, and need not be addressed in this analysis. Of the four remaining engines, all are relatively close to the standard. Data submitted by Caterpillar indicated that a decrease in injector sac volume will decrease hydrocarbon emissions. Presuming a comparable emission trend with sac volume reduction, three of the four DDA's can be brought below the target level with a reduction in sac volume from the present $.7mm^3$ to $.24\ mm^3$. The 6L-71T can be brought relatively close by sac volume reduction. Addition of an aftercooler, as already done on the 6L-71TA, easily brings it within the low mileage targets. When coupled with other injector optimizations presented, achieving compliance with these four families should be relatively easy and inexpensive.

In summary, a large percentage of diesel engines on the market today meet the 1984 target HC levels for a 10 percent AQL. Furthermore, proven strategies have been identified which will allow the vast majority of the remaining engine families to comply; many of these strategies have already been incorporated on production engines already on the market. Compliance with the transient HC standard with the 10 percent AQL for diesel engines can be accomplished by all manufacturers by 1984.

APPENDIX 4

BUDGET TRENDS

Question 1. What does EPA see as significant emerging environmental problems and how is this reflected in your research budget?

Answer. In its fiscal 1981 budget, EPA has provided for increases in research activity for four areas posing significant environmental problems in the immediate future: solid waste; toxics; drinking water; energy.

In the solid waste area, we have proposed an increase of $12.2 million and 46 positions over the fiscal year 1980 program to focus exclusively on hazardous waste: monitoring and measurement methods development and quality assurance ($4.0 million); incineration and land disposal ($6.0 million); remedial action at uncontrolled dumpsites ($3.0 million); and risk assessment. Additionally, we have shifted the focus of the ongoing solid waste research program away from a nonhazardous orientation to a hazardous orientation. This shift has resulted in a phase out of municipal solid waste, land disposal, resource recovery and large volume waste characterization activities totaling $3.3 million.

Our principal concern in the toxics area relates to the effects toxic substances are having or will have on humans and the environment. In fiscal year 1981, we are proposing increases of $9.0 million and 56.8 man years in toxics research. These resources will allow increases in the development of chemical testing protocols for absorbed dose determination methods, risk assessment methods, and a method for extrapolating effects observed in animals to humans. We also plan to initiate a major ecological research program on aquatic toxicology as it relates to the development of assays at the cellular and community levels and to expand efforts to develop and validate multimedia mathematical models for toxic chemicals. Finally, we will expand our efforts aimed at identification of toxics in sediments and initiate work on the characterization of toxics in plans and marine wetlands.

In the drinking water area, we see a real need for treatment technology specifically targeted to small communities. For fiscal 1981, therefore, we are proposing $4.3 million for the development of cost-effective technology and multicommunity cooperative arrangements for services to assist communities in meeting national and state drinking water standards.

Finally, in the energy area, EPA is proposing research to assure that the development of the synethtic fuels industry ocurrs in an environmentally sound manner. These represent an increase of $5.7 million over fiscal 80 and will focus on the characterization of emissions and effluents from the production and use of synthetic fuels and the evaluation of pollution control technology.

Question 2. The health effects program is being increased in the Air, Solid Waste, and Toxic Substances area. Why is this program increasing in these areas?

Answer. In the air area, we are requesting $2.7M to cover additional research related primarily to criteria and non-criteria pollutants. (These classifications are based upon whether or not criteria documents exist.) Clinical studies will be performed to support the projected 1983 criteria document for ozone and photochemical oxidants. These studies will examine both healthy and at-risk populations to determine the effect of oxidants on specific body functions and systems such as cardiac performance, the lung cellular function and the immune system. In addition, animal models for pulmonary disposition and clearance, techniques to assess impairment of the body's ability to fight off diseases, and models to assess carcinogenicity will be developed. Data derived from these efforts are essential to the determination of safe levels of pollutants.

The increase in solid waste will be used to initiate a new human studies program to assess neurotoxicity and congenital malformations in children. Preliminary evidence from animal studies gives reason to believe that children may be the most sensitive population-at-risk. However, no assessments of that risk have been made for children exposed to hazardous wastes such as those found at Love Canal. A portion of the increase will be used to provide a headquarters capability for providing neuro-toxicologic advice and design of a research program for reproductive effects, and coordination of efforts associated with incidences such as those occurring at Love Canal and Memphis.

The increase in the toxic substances area reflects a change in emphasis from health research directed at specific pesticides to research concerned with toxic substances in general. (Note decrease in the pesticides area.) The increase will be used to develop verified neurotoxicological protocols which are jointly planned by FDA and EPA. This research supports the regulatory process which requires evaluation of the toxic potential of chemical substances. The increase will also be directed toward the development of chemical testing protocols for methods which can determine absorbed-doses of pollutants, risk assessment methods and a method for extrapolating data from animal studies to humans. This research supports the Agency's regulatory activities under TSCA

Question 3. OMB shows EPA R&D funding at about $445 million for fiscal year 1981 (special analysis K—fiscal year 1981 Federal R&D). This exceeds ORD's request by around $75 million. Does this reflect a different accounting procedure or definition of R&D? How much research is being performed by the regulatory offices and what is the nature of this research? What does this say about ORD and its responsiveness to the needs of the regulatory offices?

Answer. The term "research", as it applies to the regulatory offices, accounts for several types of activities. EPA's abatement and control offices contract different services in support of their programs which, due to the broad categorizations used in EPA's Contract Information System (CIS), are classified as "research". However, this category may include such activities as technical guideline development, demonstrations, assessments of environmental problems, development of environmental impact statements, development of criteria documents, etc. The above activities would add to the amount of resources devoted to overall EPA R&D. The actual amount of resources devoted to true research by the abatement and control offices would include short-term technical assistance unavailable in ORD laboratories, and research for which the Office of Research and Development had neither the technical/physical capabilities to perform nor the resources to fund such projects. ORD's new research committee system is designed to air all research needs within the Agency. Each program office has been requested to supply descriptions of current activities which will be included in their respective research strategies for all committees. ORD feels strongly that this system, which was designed to enhance ORD responsiveness to the regulatory offices, will alleviate most of the difficulties that have been encountered in the past with respect to program office needs being unfulfilled.

Question 4. If the decrease in in-house personnel goes too far, it may have a negative effect on the quality of the Agency's research and its capability to respond to regulatory and enforcement needs. How does EPA intend to monitor this situation? How will EPA know when this situation becomes bad and how will EPA respond?

Answer. Although there is a definite trend toward an increasing extramural research program, it has not affected the Agency's ability to do quality research. While extramural research is a significant factor in the achievement of our objectives, we recognize that a continuing and significant trend toward decreasing our intramural staff could impair our capability to respond to regulatory and enforcement needs. We monitor the trend in two major ways. The first is by means of a new computerized system for tracking our resources, both as we implement programs and as we analyze program and laboratory impacts during the preparation of each fiscal year's program plans. The second way we monitor the trend is by a careful and continuing check of our progress toward achieving approved objectives and milestones. Should we find, in our analyses, that the quality and timeliness of our outputs are decreasing, and that this is due to a shortage of in-house expertise, we will explore a variety of means to remedy the situation. These means include, but are not limited to, requests for increased hiring authority, redistribution of assignments and responsibility to areas where there is strong staff support, and the use of the national laboratory system.

HAZARDOUS WASTE RESEARCH

Question 1. What is EPA's justification for the dramatic acceleration of research in the Solid/Hazardous Waste media?

Answer. During fiscal year 1979 the national problem associated with improper hazardous waste disposal and the even greater problem of uncontrolled hazardous waste sites became clearly visible. The Love Canal emergency and similar occurrences at a number of sites across the Country added emphasis to the problem. The Agency determined that hazardous waste management problems must be elevated to the highest priority for concentrated remedial effort. The approach to this end includes a much upgraded and visible enforcement activity, a concentrated effort to produce effective hazardous waste regulations and a determined effort to upgrade the research and development activities which supply a major portion of the technology and technical support for the Agency implementation of RCRA. The Agency, through the ZBB process, clearly recognized the need to upgrade the R&D program with immediate attention to improvement of analytical methods and quality assurance, technology for remedial measures at uncontrolled sites, research on containment and incineration technology and accelerated research into methods for treatment of hazardous wastes.

These R&D areas are in direct support of the Office of Solid Waste and the Office of Water Program Operations and are assigned very high priority. The R&D programs in hazardous waste containment, incineration, and monitoring are integral parts of the Agency's programs for establishing hazardous waste regulations and permitting hazardous waste disposal facilities.

Question 2. We are concerned that this growth rate may be too much, too fast. Is this growth rate justified? Would a more gradual, deliberate growth be prudent? Where will the people to support his growth come from? What problems do you envision and how do you plan to handle them?

Answer. The need for substantial and rapid expansion of R&D in the hazardous waste area has been carefully and intensively studied and evaluated by the Agency. The ZBB exercise for FY 1981 clearly disclosed that the existing R&D program is grossly inadequate to supply the technology and technical support the Agency needs as a sound basis for hazardous waste regulation development and enforcement action related to hazardous waste sites. The rate of growth proposed in the budget submission reflects this careful analysis.

The Agency faces a critical situation in implementing the hazardous waste provisions of RCRA and in investigating uncontrolled hazardous waste sites. The Office of Research and Development plays an integral and critical role in assuring timely and high quality information for Agency decision making. Slow response to these problems from the research program would only serve to aggravate the Agency's difficulties. Gradual growth is not considered a viable option given these circumstances.

People to support the growth are coming from a number of sources. First of all, the R&D effort has been expanded from a single division activity in one laboratory, the Municipal Environmental Research Laboratory (MERL), into four other laboratories. The analytical development and quality assurance work is being done at the Environmental Monitoring and Support Laboratory (EMSL) at Las Vegas. The Industrial Environmental Research Laboratory (IERL) in Cincinnati is focusing on methods for incineration, detoxifying or treating hazardous wastes. The Robert S. Kerr Laboratory at Ada, Oklahoma, will conduct R&D in the areas of land treatment of hazardous wastes and the fate and transport tox pollutants introduced into groundwater. To the extent necessary, the resources of the Cincinnati Health Effects Research Laboratory will also be available to contribute directly to the research program. With the additional resources of these four laboratories and the additional positions requested for fiscal year 1981 we expect to be able to adequately match staff to the fiscal resources in an efficient manner.

Because the growth in resources will occur at several laboratories and in several scientific or engineering disciplines, we do not anticipate any problem with the process of finding or recruiting capable people. We do recognize the difficult problems of managing and reviewing a program of substantially increased size, scope and complexity. The activities of the Hazardous Waste Research Committee and the efforts to assure coordination among the research, program office and regional personnel have already been expanded.

Question 3. What is happening to your work on resource recovery from Municipal solid wastes?

Answer. We must utilize available and anticipated resources in the most efficient manner. Our most pressing need is to focus most of the R&D effort on hazardous wastes. We have planned, therefore, to set aside resource recovery R&D to better focus on immediate hazardous waste problems.

The existing state of the art will permit reasonable resource recovery implementation through the Office of Solid Waste grant program and the cooperative effort by the Department of Energy. Reentry into resource recovery R&D may occur in a few years if the hazardous waste management state of the art can be upgraded sufficiently. In the meantime, only enough effort will be devoted to keep laboratory staff aware of progress in the field.

ENERGY RESEARCH

Question 1. What are the major environmental problems foreseen as alternative energy technologies are developed and go into production? How is EPA responding to these problems?

There are several major environmental problems associated with synfuels processes. These are:

Solid waste disposal—spent shale (100,000 tons per day for a 50,000 barrel per day plant) and raw shale from oil shale processes; coal preparation wastes, ash and sulfur from coal-related processes (16,000 tons per day from a 50,000 barrel per day SRC–II coal liquifaction plant).

Water availability—especially for surface processes—8,000 acre feet/year for surface retorted oil shale and 20,000 acre-feet/year for the Lurgi SNG process.

Air pollutants from all processes—especially hydrocarbons, particulates, sulfur compounds and nitrogen oxide.

Product toxicity—especially from direct liquefaction processes.

Subsidence and aquifer disruption associated with in-situ oil shale retorting processes.

The Agency has established an Alternate Fuels Group to accelerate and coordinate our efforts to support the national effort to attain a capacity of approximately two million barrels per day of synfuels by 1990 in an environmentally acceptable manner. It is anticipated that Pollution Control Guidance Documents will be completed in 1981 for the major synfuels technologies. These documents will include recommended pollution control technology data and associated cost information to support the Agency's permitting process and to provide industry with the best information on which to base their plant designs. These documents will also provide a data base which will be used by the Agency to set legally binding standards some time after 1982.

Question 2. The energy control technology program studies the expanded use of coal in utility and industrial power generation facilities. Does this program look at existing facilities using oil and assess the changes in environmental impact resulting from their conversion to coal? What happens to these assessments?

Answer. The Environmental Protection Agency is currently conducting comparative assessments of oil versus coal combustion. These studies identify and quantify the environmental residuals from the direct combustion of coal or oil. Based upon chemical analysis and comparison of the projected environmental concentrations of the pollutant species to environmental goals, an assessment of the potential for health or ecological impact is performed. This information will be used to establish a data base which can be used to assess the environmental impact resulting from the conversion to coal.

To date, a comparative assessment of oil versus coal combustion in an industrial boiler has been completed. The results indicate that, while emission differences exist and the environmental impacts differ slightly, with the proper environmental safeguards coal can be substituted for oil without undue hazard to the environment. EPA is currently evaluating the environmental residuals and assessing the potential environmental impacts associated with utility oil and coal combustion. This study should be completed by late 1980.

The data base which will evolve from these studies will be used by EPA in reviewing the environmental impact associated with coal conversion orders which are being issued by the Department of Energy.

Question 3. Is there now a surplus of residual oil that could be burned more safely than coal? and cheaper?

Answer. Based upon the Department of Energy Weekly Petroleum Status Report, the residual oil fuel stocks are about 15 million barrels above the normal range. Those increased residual oil fuel stocks above the normal range suggests that a surplus exists. The price per barrel of oil has declined from a high of $28.75/bbl (June 4, 1980) to the most recent price of $25.50/bbl (Feb. 1, 1980). The Feb. 1, 1980 price per barrel is equivalent to $4.25 per million BTU of heat.

In a recent issue of Coal Daily, the cost of coal ranged from $1.70 to $1.90 per million BTU of heat (delivered to the user). In addition to the cost of the fuel, the environmental controls would cost an additional .70¢ per million BTU. The fuel and environmental control costs are $2.40 to $3.60 per million BTU of heat. Coal is the cheaper fuel.

EPA has performed a comparative assessment of oil versus coal combustion in an industrial boiler. The results of this assessment indicate that if proper environmental safeguards are employed, coal combustion is not more hazardous than residual oil combustion.

Question 1. Acid Rain is a complex problem. How is research being coordinated within EPA and among the Agencies performing research in this area?

Answer. Acid Rain is a complex intermedia problem. Research coordination has been provided by an ad hoc research committee composed of representatives of ORD (Hq), ORD Laboratories, OANR, OWHM and Regional offices. Overall program management is the responsibility of the immediate office of the Assistant Administrator for Research and Development through the Anticipatory Research Program. An integrated five-year research plan is being drafted to provide written guidance. Research within the program is organized under the areas of monitoring, atmospheric chemistry, and environmental effects. The leader in each area is identified on page 23 of ORD's Research Summary: Acid Rain.

In addition, the program is coordinated with Canada through the U.S./Canadian Research consultation group on Long-Range Transport and with the governments of Sweden and Norway. Also, two advisory groups of outside scientists have been established for the areas of ecological effects and atmospheric transport research to help assure coordination with scientists outside the agency.

Current interagency research coordination is provided by the Interagency Acid Rain Coordination Committee (discussed below). The committee meets bymonthly to coordinate research budgetary and policy matters.

Question 2. Explain what the interagency acid rain program is and what EPA's role will be.

Answer. On August 2, 1979, in his second Message on the Environment to Congress, President Carter recognized the global magnitude of the acid rain problem and established a standing Interagency Acid Rain Coordination Committee to deal with the matter in the United States over the next ten years. Co-chaired by the Environmental Protection Agency and Department of Agriculture, with the Council on Environmental Quality serving as Executive Secretary, the policy level membership is drawn from the Departments of Interior, Energy, Commerce, State, and the National Science Foundation, Office of Science and Technology Policy and the Tennessee Valley Authority.

The committee's responsibility is to plan and coordinate a comprehensive acid rain assessment program, avoiding duplicative efforts by cooperating whenever possible with state and industrial efforts. The Committee is directed to develop a Federal Acid Rain Assessment Plan (FARAP). Public involvement in the program is encouraged by utilizing the established procedures of the agencies involved. To the extent possible, the program will be coordinated with Canada and Mexico, as well as other nations and international bodies. The Committee will report annually to the President on programmatic progress and results.

The Federal Acid Rain Assessment Plan (under preparation at CEQ) will represent the findings of a series of governmental workshops to delineate an acid rain research agenda and requisite programs in Atmospheric Transformations Processes, Monitoring Requirements Networks, and Ecological Effects. Each workshop was attended by approximately 20 to 30 scientists, administrators, and academicians. They identified and discussed current work on acid rain problems and proposed research strategies to determine the impacts of acidic deposition on the biosphere.

The workshop reports and similar preparations by one or two specialists on Problem Assessments and Analysis, Materials and International Aspects have undergone a number of reviews. Consequently, the acid rain assessment decisions have been a subject of extended, diversified debate and discussion at local, regional and national levels. The decisions have been incorporated into the plan. Two public meetings will be held to allow the public to comment on the plan.

It is expected that the plan will identify the nature, extents, and dimensions of the problems associated with acid rain. It is also expected that the plan will recommend research programs which should serve as a guide for the Acid Rain Coordination Committee in planning and guiding Agency and Departmental policies and budgets for assessing and mitigating a primary energy-related environmental problem of the United States.

In summary, EPA provides leadership to the interagency program through its co-chairman, Dr. Stephen J. Gage, Assistant Administrator for Research and Development. EPA's research program will be integrated into the Federal program as organized under FARAP.

Question 3. What is being done with the research results on acid rain?

Answer. EPA-funded research, both intramural and extramural, is conducted to support the Agency's regulatory mandate. To provide this support, research and research results must answer the questions of policy makers in the program offices and must be of high quality. Therefore, research results are communicated continually to research directors and program planners through direct transmittals and the research guidance committee. Responses, then identify further research needs.

EPA research results are published in EPA reports or in professional journals. Publication in widely circulated peer-reviewed journals is encouraged.

Also, the interagency Acid Rain Coordination Committee has called for technical meetings of researchers and research administrators to discuss results of ongoing research.

GROUNDWATER RESEARCH

Question 1. EPA's fiscal year 1981 request for groundwater research is $2.52 million, an actual decline. This seems to indicate that either you already have the knowledge needed to protect our groundwater, or you do not view groundwater quality as a significant problem, now or in the future. Which is the case? Explain.

Answer. The groundwater research resources in fiscal year 1981 will be roughly the same as fiscal year 1980. This level budget reflects decisions made in the Zero-Based Budgeting process that other problems, such as small systems treatment, require significant increases in fiscal year 1981. In a time of limited research resources, where some programs require increases at the expense of other programs, a level budget does indicate the Agency believes groundwater quality is a signficant problem.

In fact, the protection of groundwater will be improved significantly in the near future when regulations on Underground Injection Control (UIC) and the disposal of hazardous wastes are promulgated. Further, if the so-called "superfund" is enacted, this will enable remedial actions at uncontrolled hazardous waste dump-sites. Finally, there is a major effort to develop an EPA groundwater strategy. This effort will address the questions of improving our data base, the adequacy of our regulatory authorities and the character of research needed for protecting groundwater, among others.

Question 2. Groundwater experts that we have talked with say that your research on groundwater is fragmented and unsystematic. They say that your research in this area doesn't appear to be integrated toward some specific objective. How do you respond to this? How are you coordinating your research on groundwater? How could this be improved? Would the consolidation of groundwater research at the Ada Lab help?

Answer. The single main objective of the EPA groundwater research program is to develop information the behavior of pollutants in the subsurface. Supportive of this objective is the development of methods to carry out studies of the subsurface and the determination of what characteristics of the subsurface affect pollutant behavior. Other important activities include information transfer, technical assistance, and development of the data for source control criteria in support of specific regulatory activities where appropriate.

The anticipatory program in groundwater is oriented toward more long-term research on (1) the movement and transformation of organic and biological contaminants in the underground environment, (2) methods for conducting groundwater investigations, (3) the characterization of the subsurface environment.

As you can see, the research objectives of both programs are similar. Both of these programs are coordinated and managed by a single laboratory, the R. S. Kerr Environmental Research Laboratory at Ada, Oklahoma.

The objectives for groundwater research in EPA have been determined by consultation with numerous groups over the past few years. The first expression of these objectives resulted from a meeting in the fall of 1976 of an advisory group representing various EPA offices, universities, the U.S.G.S., State agencies, and consultants. They have been adjusted after reviews from within the Agency, by the Science Advisory Board, the National Drinking Water Advisory Council, and the Subcommittee on the Environment and Atmosphere of the House Committee on Science and Technology. We believe this interaction and review has resulted in a cohesive program of research, information transfer, and technical assistance. However, we are continuing to stress improvements in program relevance and scientific quality through: (1) strengthened peer review; (2) Research Committees; and (3) Agency groundwater strategy development.

Question 3. If we authorize additional funding for groundwater research, how would EPA use it? What needs to be done?

Answer. The objective of the EPA groundwater research program is to determine the movement and ultimate fate of pollutants in groundwater. Supporting objectives are methods development and subsurface characterization. Just as important are the information transfer and technical assistance activities. If additional funding in fiscal year 1981 were provided, we would accelerate work in methods development to provide the regulatory programs with more adequate means of detecting groundwater contamination, accelerate our development of predictive models for the transport and fate of pollutants in the subsurface, improve out ability to characterize the subsurface, and strengthen our effort (which we intend to begin in fiscal year 1981 anyway) to evaluate methods for aquifer rehabilitation. We generally know what needs to be done, but expect to continue to review and sharpen these needs through exchanges such as the current strategy development.

Question 4. Is EPA research done in support of regulatory authority? Is there a comprehensive and coherent groundwater protection regulatory authority? Is this why EPA research is fragmented?

Answer. EPA has regulatory authority to undertake extensive groundwater protection under the Clean Water Act, RCRA, Safe Drinking Water Act, TSCA and FIFRA. The Agency is currently reviewing these existing authorities as a part of the development of a Groundwater Strategy, to see how they might be used to address additional groundwater problems.

The EPA groundwater research program is planned to provide the scientific data for protecting groundwater from contamination, regardless of the available regulatory authority. Although the Federal regulatory authority is not comprehensive, State and local water resource managers can have a great influence on activities that could potentially pollute groundwater. A considerable portion of the groundwater research program resources are devoted to information transfer activities to educate these managers in groundwater protection. While we believe that much can and should be done to strengthen our groundwater research for the future, we do not believe our current program is fragmented.

GREAT LAKES RESEARCH

Question 1. What is the justification for EPA's action to cut the Great Lakes program by $2.0 million?

Answer. Fiscal year 1980 resources for the Great Lakes Research Program consisted of $1.6 million in the budget request and a Congressional add-on of $2.0 million to support toxic chemical studies. The budget submitted for fiscal year 1981 represents funding for the program at the $1.6 million figure. Attempts to maintain the program resources at a total of $3.6 million were not supported in the Agency's ZBB process, which determined that there were other areas of higher priority.

Question 2. Why is the Agency decreasing their research emphasis on the transport and fate of toxic material in the Great Lakes? Do we have enough information on this or is someone else going to do the research? If so, why?

Answer. Because of the cut to the Great Lakes program, we are decreasing our overall level of effort in this program. The budget justification language is admittedly imprecise. However, the Agency is not decreasing emphasis on toxics in the Great Lakes. In fiscal year 1979 and 1980, 84 percent and 86 percent respectively of the Large Lakes Research Station's budget were allocated to the study of toxic substances. This high percent of emphasis is planned to continue for the foreseeable future, but of course, the total level of effort will be less. We are pursuing model development to evaluate the inputs of toxics into the Lakes and are coordinating data collection activities with the Great Lakes National Program conducted through the EPA-Region V Office in Chicago, Illinois.

Although toxic studies under this program will be lower, there is a high level of effort in the overall Agency R. & D. program on this topic. Much of this work will be applicable to the Great Lakes area and will thus provide valuable supplemental information to the Great Lakes Research Program.

Question 3. Does EPA plan to phase out the Grosse Ile Laboratory? What is the long-term outlook of this facility?

Answer. EPA has no plans to phase out the Grosse Ile Laboratory. The high quality of the researchers at the laboratory and the extremely valuable nature of their outputs are widely recognized. EPA has no other such facility that could assume responsibility for the work now being carried out at the Grosse Ile Lab. Because of the continuing interest in Great Lakes pollution problems and the long-term characteristics of the research studies addressing these problems, it is anticipated that there will be a high level of need for the activity to remain at Grosse Ile for years to come.

DIESEL EMISSIONS RESEARCH

Question 1. The Diesel health research program is gearing down as the results of this program are becoming finalized. The validity of these results, however, are being challenged. How do you respond to this challenge? Will EPA have valid risk assessments? How will the Agency verify this?

Answer. EPA will respond to the challenge by completing its planned research to assess the carcinogenic potency of diesel emissions. The research will, of course, be changed and extended should that appear needed. The principal research being done to assess risk is skin painting, intratracheal instillation, and intraperitoneal injection of diesel soot components and other substances (cigarette smoke condensate, coke oven emissions extract, and roofing tar volatiles extract), whose human carcinogenic potency can be estimated from epidemiology for comparison of response.

The risk assessments which result from this process while of course not perfect are as good as can be done at this time. The vertification of the method for making cancer risk assessments from animal data is being pursued by many, many laboratories including EPA's.

Question 2. What have you learned about health effects of diesel emissions so far? Do we know the constituents that are harmful and in what ways given a specific exposure rate?

Answer. So far diesel soot components have given positive results in many in vitro mutagenicity tests. Such results raise a suspicion of carcinogenicity. Furthermore, diesel soot components when painted on mouse skin have produced tumors (papillomas). We are doing fractionation of extracts from diesel soot to try to determine which components are indeed most biologically active in in vitro mutation assays. Should it be useful these components could of course be put through the comparative carcinogenic potency testing described in answer 1 above.

PROGRAM PLANNING AND MANAGEMENT

Question 1. EPA is "taking steps to assure that the Agency is addressing the most important future problems and attracting the best scientific talent to work on them". How is this being accomplished?

Answer. Several initiatives have been taken during the past few years to assure that EPA is addressing the most important future problems and attracting the best scientific talent to address these problems. This has included establishing intra-Agency research committees, Anticipatory and Strategic Analysis Programs and having the National Academy of Sciences and other convening organizations bring the nation's leading health and environmental scientists and engineers together in workshops or other forums to advise us on specific problems and aspects of our programs. Of course, we have continued to benefit from the advice of EPA's SAB, whose members are themselves among the nation's most distinguished scientists and engineers.

Together, the Anticipatory and Strategic Analysis Programs, which we have recommended be combined in an Office of Exploratory Research, have greatly enhanced our capability to identify potentially significant future environmental problems and develop the basic knowledge needed to prepare the Agency for dealing with these problems. A tangible example of the former is the Environmental Outlook 1980 report. This report is a major first step in providing participants in EPA's R&D planning and policymaking processes a reasonably comprehensive integrated overview of the longer-term regional, national and global environmental outlook. Our Research Centers Program, which established epidemiology, advanced pollution control technology and groundwater research centers in fiscal year 1979, is an example of the latter. As our answer to the question will indicate, new initiatives are being taken to further enhance our futures research capability and to improve the quality of EPA science, including attracting the assistance of the nation's best scientific talent in dealing with the problems we identify.

Question 2. EPA is creating an Office of Exploratory Research to provide the capability to anticipate emerging environmental problems and provide responsive research funding to solve them. How will this be done? How will this new office operate and be structured?

Answer. The proposed Office of Exploratory Research (OER) will bring our Anticipatory Research and Strategic Analysis Programs together in a single office. The two divisions within OER will be the Office of Strategic Assessment and Special Studies (OSASS) and the Office of Research Grants and Centers (ORGC). OSASS will be responsible for producing reports which:

1. provide a reasonably comprehensive, integrated overview of the longer-term regional, national and global environmental outlook;
2. expand existing data bases and increase understanding of potentially significant future problems; and
3. evaluate concepts, methods, models and environmental controls and policies as they affect the environmental future.

Collectively, these reports are intended to:

1. produce a description of alternative future trends and contingencies and an analysis of their environmental consequences, including their public health, public welfare and policy implications; and
2. identify research which should be conducted to support the Agency's regulatory mission over the longer-term future.

ORGC will be responsible for administering the Office of Research and Development's Grants, Research Centers, Minority Institutions Research and Innovative Research programs. The design of the new Grants and Research Centers programs is intended to ensure that we get the best scientific talent to help us deal with potentially significant future environmental problems. Expanded grant solicitations tied to the long term agenda of the research committees are being developed to interest new scientists to work in the EPA. Scientific peer review and administration of all grants is consolidated in ORGC. Modelled on the procedures used by the National Science Foundation and the National Institute of Health, a panel review mechanism has been established to assure the scientific merit of research funded by and the quality of research products produced for EPA. Also, the Research Centers and MIRS program employ a competitive awards mechanism in selecting sites.

We believe the initiatives taken during the past few years, including the proposed OER either have greatly enhanced or will enhance our capability to identify significant future environmental problems and to provide the basic knowledge and analytical tools EPA needs to be prepared to address these problems. We also believe that we now have in place effective, efficient mechanisms for attracting the best scientific talent to help us achieve our environmental protection R&D mission.

Question 3. EPA is implementing a quality assurance (QA) program to improve the quality of all EPA data. Explain this program and the practices it will use. Are you developing standard measurement protocols that will be used by all your laboratories to ensure consistent management? Will this program be effective? Why?

Answer. The mandatory QA program requires participation by all Regional Offices, Program Offices, EPA Laboratories, and those monitoring and measurement efforts supported or mandated through contracts, regulation or other formalized agreements in an Agency-wide QA program. ORD has been delegated primary responsibility for implementing this program and has established a Quality Assurance Management Staff (QAMS) for developing the national QA program and directing and coordinating its implementation.

The primary goal of the QA program is to affect the establishment and use of reliable and cost-effective systems of monitoring and measurement to obtain data of necessary quality to meet planned Agency needs.

Short-term objectives are the development and implementation of QA program plans by each of the Program and Regional Offices and EPA Laboratories.

Long-term objective focus on (1) providing quantitative estimates of the quality of all data supported or required by the Agency, (2) improving data quality where indicated, and (3) documenting progress in achieving data quality.

A longer-term objective is to promote and develop optimally uniform approaches, procedures, techniques, reporting methods, etc., across media and across Regional Offices, Program Offices, and EPA laboratories. It is important (and most efficient and effective) for all organizations within EPA to employ the same QA language, consistent policies, procedures, and techniques when dealing with and interacting with the States, industry, the public, contractors, grantees, QA-involved professional societies, other governmental Agencies, and national and international organizations.

Under the mandatory QA program, each office and laboratory has the minimum responsibility to implement procedures for the quantitative determination of precision and accuracy of its measurements, and for assuring completeness and representativeness of its data. Based upon guidelines established by the QAMS, Program Offices, Regional Offices, and Laboratories will develop and implement QA program plans for their respective operational programs. The implementation of a strong QA program will depend, in large measure, upon the development of general management plans for each distinct program area, along with explicitly detailed plans for each individual project or study.

The QAMS will place priority on several special projects of major interest:

1. *Conduct QA Workshops.*—To assist in the preparation of QA program plans, QA project plans, and in the implementation of the QA requirements for contracts, grants, and other cooperative agreements, the QAMS will conduct, in cooperation with the Program and Regional Offices, EPA Laboratories, and Contracts and Grants Administration, a series of QA workshops.

2. *Establish QA Clearinghouse(s).*—Each clearinghouse will maintain listings of available reference materials, schedules of EPA interlaboratory performance audits, files of past and current QA program plans, QA project plans, annual QA reports, etc.

3. *Conduct Quality Systems Audits.*—Specific projects will be selected for onsite Quality System Audits. Audit teams will be composed of qualified individuals from offices or laboratories, other than that being audited.

4. *Perform a QA Cost Study.*—A systematic study will be made of the cost of quality-related activities within EPA. Quality-related activities, as differentiated from other monitoring and measurement activities, will be carefully defined and costs for each quality-related activity determined or estimated. This study will result in management guidelines for determining costs and cost benefits for external and internal QA programs and activities.

Development of standard measurement protocols is not a responsibility of the mandatory QA program. However, the use of standardized measurement methods, or equivalent methods, will be required practice since the QA program will mandate that precision and accuracy figures be specified for each measurement method. Measurements whose precision and accuracy do not meet minimum requirements for a specific type of analysis will not be approved or accepted.

The program will be effective because a central authority for QA has been created with responsibility for directing and implementing a unified, comprehensive, and cohesive QA program. The following chart presents the major tasks to be completed to initiate the mandatory EPA QA program. The responsible office(s) for each major task is (are) indicated with the expected completion dates.

IMPLEMENTATION REQUIREMENTS AND SCHEDULE

	Responsible office	Completion date
Agency QA policy—general	Administrator	May 30, 1979.
Agency QA policy—contracts and grants	Administrator	June 14, 1979.
Strategy for developing mandatory QA program	ORD/work group	Feb. 13, 1980.
Guidelines and specifications for preparing QA plans	ORD/QAMS	Feb. 22, 1980.
Guidelines for implementing QA requirements for grants	ORD/QAMS	Feb. 22, 1980.
Guidelines for implementing QA requirements for contracts	ORD/QAMS	Feb. 22, 1980.
Designation of QA coordinators [1]	DAAs, Labs, RAs	Mar. 1, 1980.
Model QA program plans (ambient air, water, region (laboratory)	ORD POs, ROs	Mar. 24, 1980.
Model QA project plans (ambient air-pollutant specific, water-study specific, region-area specific, laboratory-study specific).	ORD POs, ROs	Apr. 30, 1980.
Quality assurance clearinghouse	OMSQA/QAMS	May 1, 1980.
Quality assurance program plans submitted	POs, Labs, ROs	June 2, 1980.
Agency quality assurance report	QAMS	June 2, 1980.
Quality assurance programs/plans approved	OMSQA/QAMS	Sept. 15, 1980.
Quality assurance cost study report	ORD Labs, ROs	Sept. 15, 1980.
QA workshops (QA coordinators, project officers, grants administrators)	OMSQA/QAMS	To be planned.
Quality assurance project plans	Labs, POs, ROs	Oct. 1, 1980 and continuing.
Quality assurance program reviews	OMSQA/QAMS	Fiscal year 1981 and continuing.

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[1] Regions and ORD have already designated QA coordinators.

Question 4. EPA is emphasizing "enhanced accountability in the conduct of research activities". Isn't this really an attempt to gain better control, that is, to ensure that deadlines are met? You may get output when you want it, but will it be quality output? Will EPA's performance management system enhance quality research or will it promote resistance and problems? Why won't this reduce quality?

Answer. In the many cases when the results of our research are needed by EPA's program offices, these offices face inflexible deadlines. In order for our research to be of maximum utility it must be not only of high quality but also produced in a timely manner. Therefore, the key element in improving the responsiveness of our research program to Agency needs is delivering promised outputs on time.

Though we recognize that making tradeoffs between quality and timeliness may be necessary at times, these decisions will have to be made on a case-by-case basis depending on such variables as degree of urgency and the potential to improve quality given a greater period of time. The many checks and balances on our research (e.g., external peer review, line management and Agency-wide concurrences) ensure that our moves towards enhanced accountability do not unwisely trade off scientific quality for timeliness.

As for our performance management system, we believe the system takes into account many qualitative performance factors as well as quantitative ones, such as meeting deadlines, measurable work outputs, etc. Thus, an employee will be judged on the quality of his work; not only on the number of times he delivers on time. The system, therefore, provides incentives for employees to produce quality work and should not promote resistance.

Question 5. EPA is improving its reporting system to increase data delivery capability for future Agency decision-making. Will this improved data accessibility really help future Agency decision-making? How? EPA may get information quicker, but will it act if its quality is unknown? Is it possible that the delivery of some data should be slowed down to make sure it is right?

Answer. I believe that ORD's improved data accessibility will be of great benefit in future Agency decision-making. I believe this because I have not only implemented improved reporting procedures but I have also implemented several critical review mechanisms through which resource data will be evaluated. These are the peer review, program review and eventually the performance review mechanism, as I discussed in my testimony.

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